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THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

JUNE, 1917

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C. 55. The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

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OIL BURNING

Some Practical Details of Burning Oil Under Boilers to Produce Steam, with Particular Reference to Stationary Boilers, with Discussion

By B. S. NELSON, NEW ORLEANS, LA.

Member of the Society

THE subject of oil burning should be particularly interesting to engineers in the South because Louisiana can take credit for originating the widespread commercial use of oil as fuel in the United States. While a great deal of oil was produced in Pennsylvania fields and some of it was utilized for fuel purposes before the discovery of oil here, the Pennsylvania oils were of such high grade as to make them more valuable when refined into illuminating and lubricating oils than as fuel. In fact, it has been stated that for a considerable time oil companies in Pennsylvania burned coal under their boilers.

With the discovery of Spindle Top in 1901 and the rapid development of the California fields, the supply of crude oil became greater than the demand for refined products; hence the use of oil as fuel. The recent development of the Mexican oil fields has given the South an additional supply of oil to draw on as fuel.

Fuel oil is oil which is more valuable to the producer as fuel than as a refined product. Due to the rapid increase in use of gasoline in motor vehicles and the use of distillates in stationary engines, and also to the improvements in refining crude oils, it is probable that very little crude oil will be used for fuel, and that the fuel most used will be some sort of residuum or scalped oils; that is, the oil from which the lighter constituents have been distilled off. Though the Mexican oils are, as a rule, heavier and contain less of the lighter constituents than American oils, even they are now being distilled and the residue used as fuel. The result of this will be that more attention will have to be paid to the oil-burning system than was necessary with the lighter crude oils used heretofore, because a scalped oil is heavier and more viscous than crude oil. One advantage in using a scalped oil is that there is less fire risk, because its flash point is higher than the flash point of the crude oil.

Fuel oils may be classified according to several of their characteristics, which are more or less dependent upon each other. Some of these are the flash point, or temperature at which an oil will give off inflammable vapors; the viscosity, which may be explained as the molecular friction; the specific gravity; the heat value, and the sulphur content.

The flash point of an oil is of interest particularly from the standpoint of safety. On land installations, where the oil is usually buried in a closed tank, the flash point is of less importance than on shipboard, where inflammable vapors are apt to accumulate in the hull or to be freed in a closed boiler room, due to leaky piping.

The viscosity of an oil is the principal consideration in the actual burning of that oil, because the success of the burner or atomizer depends largely on its ability to atomize the fuel into sufficiently fine particles to insure satisfactory combustion, and the more viscous the oil the more difficult this atomization. There are various methods of expressing the viscosity, one of the most used being in terms of the Engler scale. Degrees Engler means simply the ratio of the time it takes a given quantity of an oil to flow through a standard orifice as compared to the time it would take the same volume of water to flow through. Oil is usually sold, however, on the basis of its specific gravity (generally measured in degrees Baumé) and its heat value and moisture content. It is usually assumed that the heavier an oil in degrees Baumé, the more viscous is that oil, but this is not always strictly true.

Through the courtesy of E. H. Peabody, Mem.Am.Soc.M.E., in Fig. 1 is reproduced a very interesting chart giving the characteristics of some thirty different oils. This chart gives the temperature-viscosity diagram of these fuels, the specific gravity, the degrees Baumé and the flash point. Comparing two crude oils from these curves brings out the relation, or rather lack of relation, between degrees Baumé and degrees Engler:

	Deg. B.	Flash Pt.	Deg. Eng. at 230 Deg. Fahr.
Panuca Crude.....	13.7	140	13.75
No. 18 California.....	12.7	285	5.2

It is to be regretted that oil is not specified in terms of specific gravity instead of degrees Baumé, because in any calculations involving the weight of the oil per gallon or per barrel it is necessary to refer back to specific gravity. Further, the heaviest oil that can be designated on the Baumé scale for liquids lighter than water is 10 deg. B., or unit specific gravity. There are oils being used now of 10 and 12 deg. B., and no doubt still heavier oils will be used, which will call for two different Baumé scales and cause confusion.

Spindle Top oil has a specific gravity of about 0.92, corresponding to 22 deg. B., and its heat value averages about 19,700 B.t.u. California oil is somewhat heavier, the average grade of that oil having a specific gravity of about 0.95, or 18 deg. B., heat value about 18,500 B.t.u. The Mexican oils vary considerably in specific gravity and heat value, but as a rule they are much heavier than either the California or Texas oils; a typical oil now used has 0.99 sp. gr., or 12 deg. B., with a heat value of about 18,200 B.t.u.

Table 1 compares the prices of coal and oil, taking as a basis coal of the quality of Pratt, Alabama, and Pittsburgh coal, sold in the New Orleans market. While with these coals an evaporation of 10 lb. from and at 212 deg. can be realized with well-designed water-tube boilers when the boilers have ample heating surface and are in the hands of skillful firemen, it is extremely doubtful if any boilers in regular service are showing better than 8 lb., and the great majority are below this figure. Therefore, if we take 8 lb. as a basis, we are giving the coal its full value. Now, with oil giving 19,500 B.t.u. per lb., an evaporation of 14.5 lb. should be readily obtained if the apparatus for supplying the oil to the furnaces is of first-class design and if the furnaces are properly arranged. With this ratio as a basis, it is apparent that a pound of coal is equivalent to 8/14.5 or 0.541 lb. of oil. A barrel of crude

Presented at a joint meeting of the Louisiana Association of Members of the American Society of Civil Engineers and the New Orleans Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, January 22, 1917.

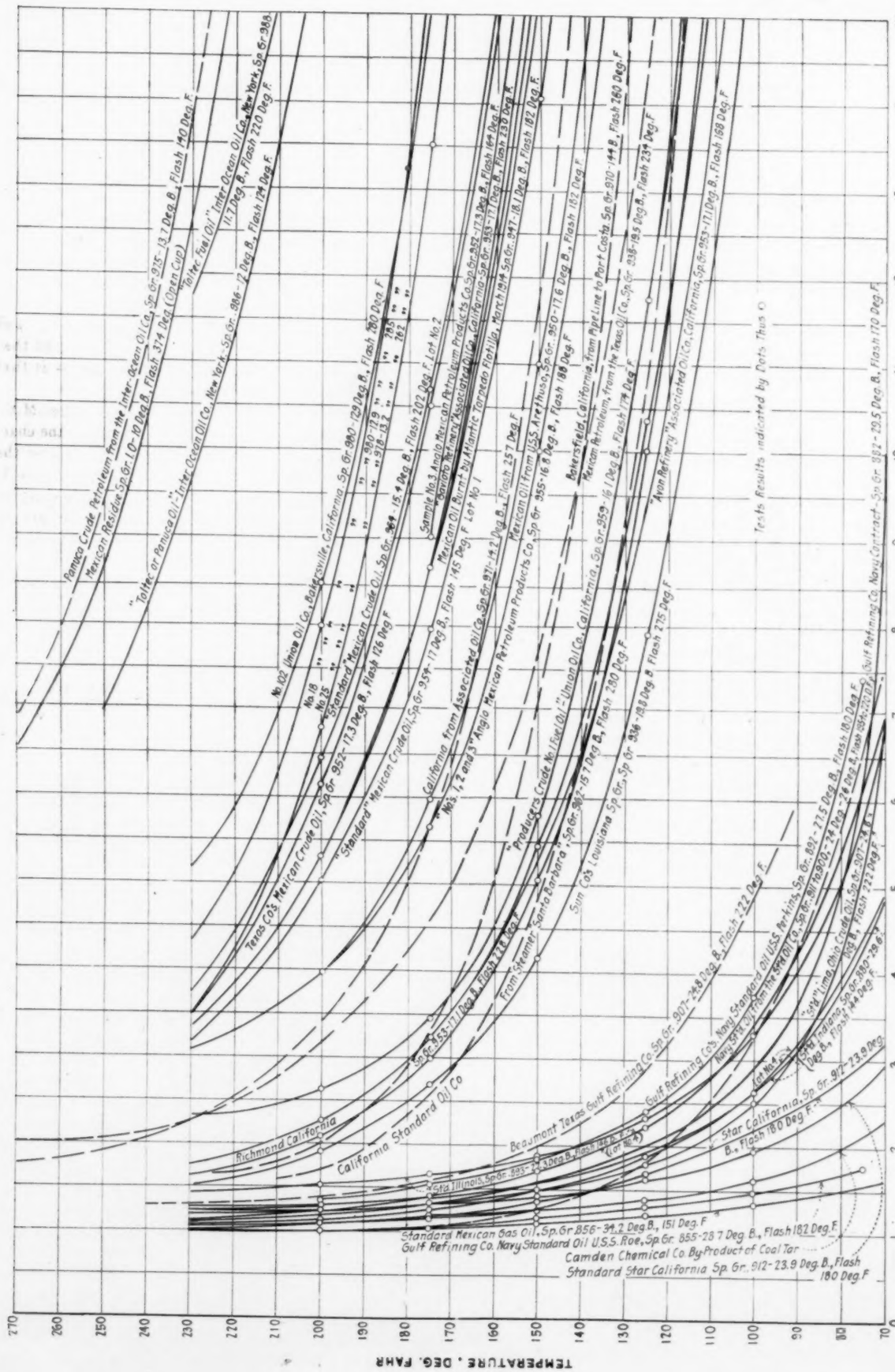
VISCOSITY, DEG ENGLER
TEMPERATURE, DEG. FAHR
Tests Results indicated by Dots Thus ○
Panuco Crude Petroleum from the Inter-Ocean Oil Co., Sp Gr 935-13.7 Deg B., Flash 140 Deg F.
Mexican Residue Sp Gr 1.0-10 Deg B., Flash 374 Deg (Open Cup)
"Tolter or Panuca Oil" Inter-Ocean Oil Co., New York - Sp Gr. 986-12 Deg B., Flash 174 Deg F.
"Tolter Fuel Oil" Inter-Ocean Oil Co., New York, Sp Gr 988-11.7 Deg B., Flash 220 Deg F.
No. 102 Union Oil Co., Bakersfield, California, Sp Gr 940-19 Deg B., Flash 180 Deg F.
No. 18 " " " " " " " " " " " "
No. 25 " " " " " " " " " " " "
"Standard" Mexican Crude Oil, Sp Gr 952-17.3 Deg B., Flash 126 Deg F.
"Standard" Mexican Crude Oil, Sp Gr 959-17 Deg B., Flash 145 Deg F.
Sample No. 3 Anglo Mexican Petroleum Products Co. Sp Gr 952-17.3 Deg B., Flash 164 Deg F.
Sample No. 3 Anglo Mexican Petroleum Products Co. Sp Gr 953-17.1 Deg B., Flash 238 Deg F.
Mexican Oil Burnt by Atlantic Torpedo Flotilla, March 1914 Sp Gr. 947-18.1 Deg B., Flash 182 Deg F.
Santa Maria Refinery Associated Oil Co., California, Sp Gr 953-17.1 Deg B., Flash 168 Deg F.
California from Associated Oil Co., Sp Gr 971-14.2 Deg B., Flash 257 Deg F.
Mexican Oil from U.S.S. Arethusa, Sp Gr. 960-17.6 Deg B., Flash 182 Deg F.
Nos. 1, 2 and 3 Anglo Mexican Petroleum Products Co., Sp Gr 955-16.9 Deg B., Flash 188 Deg F.
"Products Crude No. 1 Isle (Oil)" Union Oil Co., California, Sp Gr 959-16.1 Deg B., Flash 178 Deg F.
Petersfield, California, from Pipe Line to Port Costa Sp Gr 910-24.4 B., Flash 262 Deg. F.
Mexican Petroleum, from the Texas Oil Co., Sp Gr 938-19.5 Deg B., Flash 234 Deg F.
Avon Refinery Associated Oil Co., California, Sp Gr 953-17.1 Deg B., Flash 168 Deg F.
Sun Oil Co Louisiana Sp Gr. Sp Gr 936-19.8 Deg B. Flash 235 Deg F.
From Steamer "Santa Barbara" Sp Gr. 967-15.1 Deg B., Flash 230 Deg F.
Texas Oil Co's Mexican Crude Oil, Sp Gr 952-17.3 Deg B., Flash 218 Deg F.
Gulf Refining Co., Navy-Standard oil U.S.S. Perkins, Sp Gr. 891-27.5 Deg B., Flash 180 Deg F.
Navy-Std. Oil from the Std. Oil Co., Sp Gr. 891 to 890-27 Deg - 24 Deg B., Flash 222 Deg F.
Gulf Refining Co's Navy-Standard Oil U.S.S. Roe, Sp Gr. 891-27.5 Deg B., Flash 180 Deg F.
Star California, Sp Gr. 912-23.9 Deg B., Flash 180 Deg F.
Richmond California
California Standard Oil Co
Beaumont Texas Gulf Refining Co. Sp Gr. 901-24.8 Deg B., Flash 222 Deg F.
Texas Illinois, Sp Gr. 935-19 Deg B., Flash 182 Deg F.
Standard Mexican Gas Oil, Sp Gr 856-34.2 Deg B., 151 Deg F.
Gulf Refining Co. Navy Standard Oil U.S.S. Roe, Sp Gr 855-28.7 Deg B., Flash 182 Deg F.
Camden Chemical Co. By-Product of Coal Tar
Standard Star California Sp Gr. 912-23.9 Deg B., Flash 180 Deg F.

FIG. 1 TEMPERATURE-VISCOSITY DIAGRAM OF FUEL OILS

Reproduced from Curves of Lieut.-Comm. John J. Hyland, U.S.N., with additions (shown in dotted lines) by E. H. Peabody, Mem. Am. Soc. M. E.

oil weighs approximately 325 lb., therefore one ton (2000 lb.) of coal is equivalent in practical heating value to 3.34 bbl. of oil.

TABLE 1 COMPARISON OF PRICES OF COAL AND OIL

Coal, Dollars per Ton, 2000 lb.	Oil, Dollars per Bbl.	
5.00	1.50 [1]	1.66 [2]
4.75	1.43	1.60
4.50	1.35	1.50
4.25	1.28	1.42
4.00	1.20	1.33
3.75	1.13	1.25
3.50	1.05	1.02
3.25	.98	1.01
3.00	.90	1.00
2.75	.83	.92
2.50	.75	.83
2.25	.68	.75
2.00	.60	.66

[1] Not allowing for labor saving.
[2] Assuming 10 per cent of cost of fuel in labor of firing and handling ashes saved by using oil, a conservative estimate for plants of over 300 hp.

An interesting point to note with reference to the heat value of an oil is that the B.t.u. usually given is the high heat value or heat value determined in a bomb calorimeter. The actual heat value available in a boiler furnace is less because all fuel oil contains a considerable percentage of hydrogen, and the latent heat of the steam formed by the combustion of this hydrogen passes up the stack as waste heat.

In all the heavier grades of fuel, particularly the Mexican oils, water mixed with the oil is in the form of an emulsion and will not settle out in a tank as it will with the lighter American crudes. This is not so much a disadvantage as it would seem, other than causing a lowering of the heat value. With an oil light enough for the water to settle out of its own accord, this water will frequently accumulate in the tank and piping and go over into the burners in a slug, putting the burners out; but with heavy oil a very considerable amount of water can go through the burner with no bad effect. The writer is inclined to believe that a small quantity of water in heavy oil is an advantage in that these oils are usually heated above the boiling point of water to effect atomization, and the vaporizing of the moisture in the oil as it leaves the burner tip probably helps to atomize the oil more thoroughly.

Oil has numerous other advantages over coal than cost of fuel. The storage space required is much less for an equal number of heat units; there are no ashes to be disposed of; less boiler-room help is required for firing; the wear and tear on the furnace lining is smaller because the firedoors do not have to be opened, with the consequent chilling of the hot brickwork. Very little repairs are necessary to the grate bars; a much smaller stack can be used for the same boiler horsepower; the boiler can be forced with natural draft considerably beyond what it can with coal, an important feature where boiler capacity is scant; where feedwater is bad, it is often possible to carry a load with two oil-fired boilers which would require three boilers were coal used, thus allowing the cleaning and repairing of one dirty boiler at a time. Steam can be raised much more quickly and with no loss due to banking fires. It takes about 10 per cent of the fuel normally consumed by a boiler at rated load to keep its fire banked with coal. In case of an emergency the fire can be instantly extinguished; any one who has had to draw a hot coal fire in an emergency can appreciate this particular advantage.

THE SUCCESSFUL OIL-BURNING INSTALLATION

There are several factors entering into the successful oil-burning installation, some of which affect the reliability of the system and others its efficient operation.

The first consideration for reliability is the oil supply to the burners, involving the storage tanks, pumping outfit, and heaters. The size of a storage tank varies, of course, with the size of the boiler plant, but it should be large enough, at least, to hold a carload of oil. A very popular size of tank is a 10,000-gal. tank, which is about 8 ft. in diameter and about 30 ft. long. These tanks are usually built of $\frac{1}{4}$-in. steel with $\frac{3}{8}$-in. heads, though if the tank is subject to corrosion from the outside it should be made of heavier material. The tank should be equipped with a manhole and filling pipe, a suction opening, a vent opening, and openings for steam-heating-coil connections. The insurance requirements call for the tank to be below the level of the pumps and burners, which means that it is usually buried in the ground. The tank should be preferably not less than 50 ft. from the nearest building.

The oil pumps are the next consideration. The pump that has given the best results is a duplex steam pump, piston-pattern type, with brass valves, metallic packing in the oil piston and special gaskets and piston-rod packing. The size of pump should be based on a very low piston speed.

The pump should be fitted with an air chamber on the discharge side to steady its pulsations of pressure, and a governor on the steam end to maintain the pressure constant. The pressure at which the oil is delivered to the burners depends largely on the character of the oil, varying from 40 lb. for oil of 26 to 30 deg. B. to 80 lb. for oil of 12 deg. B. The pump should also be equipped with strainers on the suction side to keep trash from getting under the pump valves. Duplicate pumps should always be installed, so that if anything goes wrong with one pump the other may be put in service without shutting down the plant.

The pump should be set as near the level of the oil as possible to give the minimum suction lift, and the suction pipe should be as straight as possible, preferably with bends instead of elbows. Where the suction pipe is long, a foot valve at the bottom of the suction line in the tank is desirable. This should be a valve without leather seats, as fuel oil deteriorates leather. A very good valve to use is a horizontal-swing check used in a vertical position. In addition to air chamber and governor, the pump should be equipped with a relief valve set at a pressure heavier than the working pressure, so as to minimize the danger of breaking the pump. This relief valve should be of the enclosed type, so that its overflow can be piped back to the tank.

The heavier oils require heating in the suction tank in order to enable the pump to lift them. The temperature must not be high enough to cause the oil to vaporize under the suction pull of the pump. The writer has found a temperature of 110 to 130 deg. about right for Mexican oil of 12 to 18 deg. B. According to Commander John J. Hyland, U.S.N. (*Jour. A. S. N. E.*, May 1914), the viscosity of the oil had to be reduced to 375 deg. Eng. in order to obtain full capacity from a Blake pump. In order to gage this temperature accurately, a thermometer should be installed in the suction line near the pump. If this suction line is long, or has several elbows in it, it should be made one or two sizes larger than the suction opening of the pump.

The next question is that of the heater. Practically all the oil now burned as fuel requires heating in order to reduce its viscosity and facilitate atomization at the burner. There is a wide choice of heaters, but the principal considerations are,

first, to have the heater of ample heating surface, and second, to be sure that this heating surface is all utilized. In heating oil with a steam coil in a vessel of oil there is a tendency to local heating, that is, the oil next to the coils may be very warm; but this heat is not readily transmitted to the adjacent oil, so that a heater in which the oil is kept in rapid motion over all the heating surface in the coil is apt to give best results. In one type of heater the oil is sent at high velocity through a long coil of brass pipe heated by steam on the outside.

There are several pumping sets on the market which combine all the requisites enumerated above in one self-contained unit. Fig. 2 shows such an outfit which, it will be noted, consists of duplicate pumps with pressure governor, air chamber, gage, suction strainers on pumps, relief valve and heater.

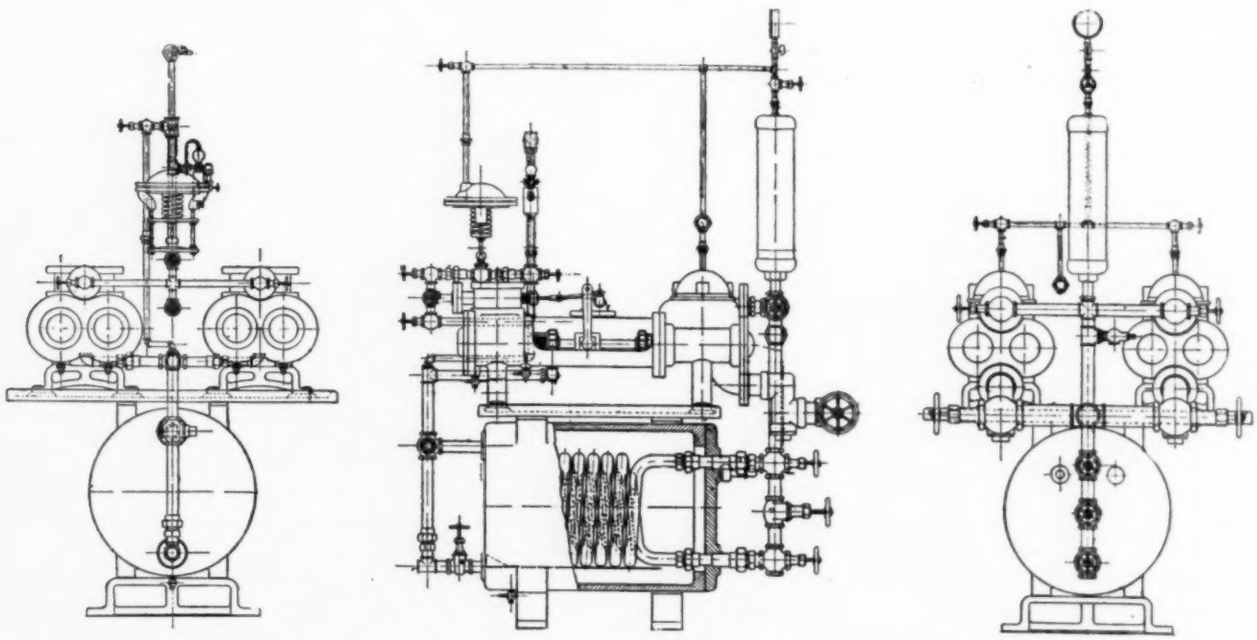

FIG. 2 OIL-PUMPING SET, SHOWING DUPLICATE PUMPS WITH PRESSURE GOVERNOR, AIR CHAMBER, GAGE, SUCTION STRAINERS, RELIEF VALVE AND HEATER

The temperature to which the oil must be heated naturally varies with its viscosity. For fuel oil usually burned in the South, a temperature from 180 to 220 deg. is satisfactory, the higher temperature being for oil of 12 deg. B. As far as we know, no experiments have been made to determine the degrees Engler to which oil must be heated, but judging from our experience and with the aid of the temperature-viscosity diagrams, we should say that about 8 to 9 deg. Eng. is the viscosity required for a steam-atomizer burner. It has been stated, however, that any oil which can be pumped readily can be atomized by a steam atomizer. After the oil is heated at the pump (and its temperature should be read by a thermometer permanently fixed in the discharge line from the pumps), care should be taken to keep the oil hot until it reaches the burner by proper covering of the pipes. Where the discharge line is very long or the oil pump is a considerable distance from the burners, a very helpful device is to run a small live-steam pipe inside the oil-discharge pipe. When this is done, a stuffing box should be placed at one end of the steam pipe to take care of expansion, which will be greater on the steam than on the oil pipe.

In an installation where the burners are shut down for any length of time, a bypass should always be provided from the farthest end of the oil supply to the burners back to the pump suction, or preferably to the tank. The function of this is to be able to fill the oil header with heated oil before attempting to light the burners. With much of the heavy oil now used, it will be found impossible to even light the burner until hot oil reaches the burner tip. If the above bypass is not used, there will be considerable messing up of the furnace and ashpit with unburned oil.

More stress has probably been laid on the oil burner than on any other part of the installation, which has led to the belief on the part of people unfamiliar with the burning of oil that the burner is the whole thing, whereas, as a matter of fact, the burner contributes but a very small part to the success of the installation. The term *burner* is really a misnomer, because the only function the burner performs is to atomize the fuel into sufficiently fine particles to effect complete combustion in the furnace.

For land installations, the type of burner which has proved best is the steam-atomizer burner with oil supplied to it under pressure. The essentials of such a burner are simplicity, cheaply renewable wearing parts, economy in steam for atomizing, and the production of a flame of such shape that makes good combustion and, hence, high boiler efficiency possible. The burners may be of either the round-flame or flat-flame type. The flat-flame type is preferable because it uses less steam for atomizing and produces a flame of such shape as to permit proper mixture of air to support combustion without excess air, which is not the case with a round-flame burner.

The use of a target wall is not necessary and may cause injury to the heating surface of the boiler by causing the flame to concentrate on a small portion of the surface, resulting in what is termed "blowpipe" action.

The general type of flat-flame burner is a tip in which are two narrow parallel and horizontal slots, the oil flowing out of the upper slot in fan shape on to the fan-shaped jet of steam issuing from the lower slot.

The position of the burner depends largely on the type of boiler. For a boiler with a long unobstructed furnace, such as a horizontal return tubular, or a boiler of the Heine or Erie City type, a burner set in the firing door is very satisfactory. For boilers where the furnace is short and the travel of the gases is upward, such as in the Babcock & Wilcox or Stirling boiler, the best arrangement is to put the burner at the back, shooting toward the front of the boiler. In either case air should be admitted to the furnace through a checkerwork of firebrick laid on the grate bars. The shape of this checker work should approximate the shape of the flame and thus reduce excess air, and the area of all the holes should be equal to 4 sq. in. per boiler horsepower.

Steam and oil connections to a burner should be made to allow for the expansion and contraction of the oil and the steam headers, and should have unions above and below the burner to enable the latter to be taken out quickly for cleaning. A very essential point in installing a burner is to see that it gets dry steam. The simplest way to do this is to take the steam from the top of the auxiliary steam header. A steam connection should be provided on each burner for blowing the oil out of the burner when it is shut down, as otherwise this oil will carbonize, due to the heat radiated from the hot furnace.

The principal consideration affecting the efficiency of an oil-burner installation, other than the choice of a burner economical in the use of steam (and giving the proper shape of flame), is the proper control of the air supply. One of the advantages of burning oil, mentioned above, was the possibility of reducing the excess air to effect combustion. Conversely, one of the principal losses is the ease with which excess air can be admitted. For any particular installation (assuming the setting is tight and checkerwork properly arranged), the best draft should be determined by installing a draft gage on each boiler connected to the furnace, then gradually closing the damper until there appears just a faint trace of black smoke at the stack, and finally maintaining the draft at that point. It should be noted, however, that there can easily be smoke with excess air for two reasons, first, if the checkerwork is not properly arranged in the furnace there will be excess air, even though the combustion be incomplete, and second, poor atomization of the oil at the burner will give a grayish-white smoke, which is often mistaken for insufficient air. A more accurate method of gaging the air supply is to make periodical analyses of the stack gases and keep a record of the stack temperatures. The stack gases should not be over 100 deg. hotter than the steam, and no difficulty should be experienced in getting 13 to 14 per cent CO_2 in regular operation.

DISCUSSION

MR. SNYPP GIVES THE REQUIREMENTS FOR SUCCESSFULLY FIRING HEAVY CRUDES

CHARLES E. SNYPP spoke of the difficulties experienced in handling and firing heavy Mexican crude oils. He recited an experience in which these heavy crude oils were substituted for the lighter crude oils, such as Spindle Top, Beaumont and Louisiana oils, in a plant especially adapted to the burning of lighter grades. Fortunately for the continuous working of the plant, the change came about gradually over a period of a couple of years, and thus the machinery was corrected and adapted from time to time to the heavy grades.

Owing to the rigid insurance requirements, the supply tank was located about 400 ft. distant from the boilers, and about 2 ft. beneath the level of the burners. This tank was buried and dirt arched over the top to supply the necessary weight to overcome its buoyancy when empty, as the ground was more or less saturated with water.

The pump which supplied the burners was located in the boiler room, and light crude of 22 deg. B. could be easily drawn through a 1½-in. pipe by pump suction without heating. For heavy crudes a 3-in. pipe was substituted and a large-capacity, slow-motion pump was used. This would handle medium grades, but in cold or wet weather the arrangement was too delicate to be relied upon. A booster pump was then located at the tank, and oil was heated to 130 deg. fahr. and forced through this 3-in. pipe. This relayed the oil to the burners. A 2-in. overflow pipe was laid from the pump, located in the fireroom, to a return pipe to the ground tanks. This slow-motion pump was speeded by allowing oil to flow freely through a ½-in. vent pipe located in the top of the pump chamber and controlled by a gate valve, and this oil circulated through the 2-in. pipe to the ground tank. This proved to be a very satisfactory arrangement for handling Mexican crudes.

Mexican crudes of 12 to 13 deg. B. should be heated to 120 to 130 deg. fahr. and delivered to the burners just under the distilling temperature, which is about 250 deg. fahr.

Superheated steam was found to be beneficial in atomizing this oil and delivering it to the fires. (The speaker had no data on the amount of preheat used, but believed that the oil should be delivered in a gaseous state to the fires.)

A 3-in. closed tube about 8 ft. long was located in the bottom of the firebox between two burners, and protected with one thickness of firebrick. Steam from the boilers was led through the front end of this tube through a ½-in. pipe, and the pipe extended to the rear end. A ¼-in. pipe was led from the steam space of this tube to the burners. The fuel oil was fed through a ¼-in. pipe into the rear end of a ¾-in. pipe which was inserted into this tube, extending the full length of the tube. Thus the oil was preheated by superheated steam and the superheated steam was used for atomizing.

The oil, flowing from the pump, located in the fireroom, was heated by the usual exhaust heater at the pump, then passed through a live-steam heater before entering the superheated tube.

The requirements for successfully firing heavy crude oils seem to be, first, large pipe lines and slow-moving, large-capacity pumps; and second, proper preheating; third, superheated steam to atomize the oil.

MR. BURWELL BRINGS OUT POINTS NEEDING SPECIAL ATTENTION IN OIL BURNING

ROBERT T. BURWELL. Wherever any trouble with oil burning under boilers has occurred, it has generally been of a local nature, due to the impinging of the flame on some portion of the boiler, or to the scaling of the boiler, more than to anything else, and where the oil is properly distributed, we may expect as much life from the oil-fired as from the coal-fired boiler.

We thought when the Beaumont field was discovered that, inasmuch as this oil gave such a driving-hot fire—boilers could be forced so easily—the boiler would show defects much more quickly, but we have not met with anything of that kind in our experience. The railroads now drive their boilers rather hard, and yet they do not seem to have any such trouble. They have to be careful that the oil is well distributed so that the flame will not impinge against the tubes, and for that reason most of them place the burner at the front of the firebox so that the flame passes to the rear first.

As to the type of burner, Mr. Nelson has pointed out the

advantages of the flat burner. It has the additional advantage that it is not so apt to force the flame against the boiler as is a round burner; the flat burner seems to distribute the fire more equally across the chamber. I am glad to see that they are doing away with the target, which formerly caused us a good deal of uneasiness because the flame would strike the target and be deflected for a long time on one portion of the boiler, a condition that does not exist in a coal fire.

Those who are using oil should bear in mind that they can force a boiler very easily, and in forcing it they should also bear in mind that the more it is forced, the more important it is that the feedwater be of good quality.

In reading over the Government Report on oil burning, one is struck with the emphasis placed on the importance of having good men in charge of the burners. This factor does seem more important than in the case of burning coal, and yet we know that there is frequently considerable difference in efficiency of men firing coal.

An efficient fireman is very important to the economical operation of a plant. One of the best illustrations of the saving by a good fireman was shown in a test made at Milwaukee burning coal, where very accurate data were taken covering a period of twenty-four hours. This test was started at 9 a. m., when fireman *A* was on duty, and his showing at the end of five hours was 9.98 lb. of water per lb. of dry coal. Fireman *B* then came on and his watch lasted 8 hours, during which time the rate was 9.23 lb. At 10 p.m. fireman *C* came on for 8 hours, and showed exactly the same amount as *B*, namely, 9.23 lb. It was thought that the discrepancy was due to the boilers being cleaner during *A*'s watch, but he came on the next morning at six, and during the three hours to the end of the test made a showing of 9.87 lb. At the average price of coal this plant would save $2.40 per day by having firemen like *A* instead of *B* or *C*, and yet these three firemen were supposed to be in the same class. It is quite probable that many of our plants which have to select practically a new crew every year, such as our sugarhouses, must suffer in economy from this source.

Mr. Nelson has also pointed out the importance of a proper distribution of the air and a regulation of the air to reduce the excess air to a minimum, to which we might pay more attention with a view to developing a system by which we can determine exactly what we are doing in a plant. Mr. C. R. Weymouth, in Vol. 30 of Trans.Am.Soc.M.E., gives a table showing the boiler efficiency corresponding to varying percentages of excess air.

Referring to burners, while it appears that it does not make much difference about the type of burner, yet the Government Report gives the results of a test of the Korting mechanical burner showing an evaporation of 16.13 lb. of water from and at 212 deg. fahr. The temperature of the oil at the burners was 162 deg. fahr, and its pressure was 105 lb. per sq. in.; the temperature of the air entering the furnace was 250 deg. on one side and 290 deg. on the other, and the temperature of the gases at the fan suction was 465 deg. This result (16.13 lb. water) is unusually high, and with a burner that uses neither air nor steam to atomize the oil. The oil under pressure is forced through screw threads to the nozzle, the orifice of which somewhat resembles an injector. Most authorities place a limit of 130 deg. fahr. to which the oil shall be heated, and yet in this test the oil was heated to 162 deg., giving the best results that I have been able to find.

One point not yet touched on is the importance of having ample room in the combustion chamber. As a matter of fact, I think a small Dutch oven would give better results. I recall a power plant in this city where the boilers equipped with Murphy stokers were fitted up some years ago to burn oil—simply by lining the bed of the stoker with brick the fire had a clear sweep to the combustion chamber beneath the boilers. It was apparently the most perfect fire I have ever seen.

The form of furnace undoubtedly has considerable effect upon the temperature of the fire; in the case of a fuel in which a considerable portion burns as a gas, if these gases come in contact with a cool surface such as the boiler, before combustion is complete, there is a corresponding loss. It requires a temperature of about 1500 deg. fahr. to burn carbon monoxide, and it would therefore seem desirable that the furnace be of such proportions as to keep the gases above this temperature until complete combustion is assured.

An interesting illustration of the effect of the temperature of the fire on the burning of a fuel is seen in the case of bagasse. Green cane contains about 76.5 per cent water, thus if 10,000 lb. of cane were dried and the water caught, we would have 7650 lb. of water. The dry matter will burn readily and produces sufficient heat to evaporate more than 7650 lb. of water per 10,000 lb. of cane. The reason green cane will not burn is because the water in contact with the combustible matter prevents the temperature from attaining a point necessary for combustion.

My observations indicate that there is a practical operating condition against the use of oil in a bagasse furnace; as a rule, the man in charge is too prone to wait until the blowing of the safety valves notifies him that it is time to shut off the burner, whereas in using coal he is not apt to add it any more frequently than the condition of the bagasse fire demands. I recall one house that burned coal with bagasse with good results, but reported unsatisfactory results with oil. Of course, this is a condition that can be improved by careful supervision; it emphasizes, however, the importance of capable men in charge of the burners.

Speaking of forcing boilers, the Government Report calls attention to the fact that a burner has a limit, and it is impossible to force a boiler with an insufficient number of burners. This suggests the idea that in many instances more burners might be used to advantage; a greater number might also permit a wider range of regulation.

PROFESSOR WILLIAMSON DISCUSSES THE HEATING OF THE OIL AND ALSO ITS ATOMIZATION BY AIR

PROFESSOR C. S. WILLIAMSON. I do not know much about tests on oil burning, but it stands to reason that provided you do not reduce the oil to the elemental condition, in which case carbon would be deposited, the more nearly broken the oil is, the greater the heat value obtained, for this reason: we are all perfectly familiar with the fact that if a certain product—take a chemical compound, for instance—requires so many heat units to decompose it, we have put in that many heat units before we begin to get back any heat units from its actual combustion. Oils should not be heated above their flash points nor to a temperature at which carbon is separated. This temperature depends upon the property of the particular oil undergoing use or test, and so the flash temperature will vary.

Another point is the free play of the flame. It might not be accurate to so designate it, but it often causes a loss to the boiler efficiency, for if you impinge the oil flame on the boiler, the oil will split and produce a tarry residuum which drops into the pit, thereby losing a portion of the oil, although getting the best heat value possible for the oil actually consumed. There is a certain point, which varies for different oils, at

which the separation will take place, but one would have to determine this point for each oil to tell at what temperature the oil can be most economically preheated. If then the oil is preheated too highly, causing separation at this point and, further, the flame is allowed to impinge against the boiler plate, we have the formation of a residuum at two places, one (the former) of which may clog the burner, and the other produce the tarry residue in the pit below the furnace. The temperature of the flame at the point of combustion is considerably above that of the boiler plate, which possibly does not exceed 300 deg. fahr. in most cases. Hence the boiler plate will act as a condenser to the tarry residue, which has a higher boiling point than the surface upon which it is formed, and the cause of inefficient burning may be this mechanical arrangement instead of the oil being low in heat units. There is a splitting point then for different oils, which varies as mentioned.

There is a method of atomization which has not been spoken of, but which also gives good results where the installation is large enough to warrant putting it in, and that is compressed air. If you do your atomizing with compressed air, you do away with the steam you have accounted for in the absorption of heat. So where the plant is large enough, this method can be worked very successfully. It is somewhat a question of the amount of water which you introduce, in case of steam, as pitted against the nominal amount of water introduced in the case of air; also of thoroughly mixing the oxygen with the particles of oil as they are atomized.

MR. LEBERMUTH DISCUSSES COMBINATION OIL AND BAGASSE FURNACES

C. D. LEBERMUTH.[1] Mr. Burwell has struck the keynote in bagasse burning when he mentioned getting rid of the water. Not only is the heat value per pound of bagasse raised with a reduction of water, but also the heat value per pound of fiber. This has been worked out theoretically and experimentally by Prof. E. W. Kerr, Mem.Am.Soc.M.E. In practice it has been equally well demonstrated, where factories have reduced the moisture from 52 to 56 per cent, the limits in ordinary Louisiana six-roller mill work down to 47 per cent, now obtained by the best nine-roller mill plants.

It has been shown that under normal Louisiana conditions, 75 per cent excess air is about the minimum practicable in order to keep fires burning, this excess air being necessary in order to dry the water out of the bagasse. It can readily be seen that with this as a minimum and with the ordinary operating condition being about 100 per cent excess, bagasse-furnace conditions are not at all suited for burning oil. In every case where these fuels have been tried together the results have been poor. At Meeker, built as recently as 1912, such combination furnaces could never keep up steam until they were changed and the oil and bagasse fired separately.

At the Gramercy Refinery, some years ago, they found when they were grinding cane about 1000 tons a day, the fuel rate in the refinery was practically the same as when they were not grinding. They felt that the bad influence of the bagasse on the oil-furnace conditions overbalanced all the fuel value that they got from the bagasse. Now that no grinding is done they have some well-perfected furnaces using oil which give them from 72 to 74 per cent total furnace and boiler efficiency right along, and I saw the results of a 72-hour test there, where they obtained a total furnace and boiler efficiency of 80.4 per cent with return tubular boilers. From any other source than their chief engineer, such a figure looks almost too good to accept on its face value. But as I received it I feel sure of its validity.

What is needed in the way of a combination furnace is one which will burn bagasse efficiently and permit of burning oil to run boilers full load, efficiency not counting in this case at all. For oil will only be used when the milling tandem is stopped, which occurs only at infrequent intervals. It is simply a matter of getting the same horsepower out of the bagasse boilers during these stops.

[1] Lebermuth & Israel Planting Co., New Orleans, La.

MR. HUTSON DISCUSSES THE HANDLING OF MEXICAN OIL

H. L. HUTSON. When the Mexican oil companies first sent men up here to sell their oil, they sent an engineer to give instructions as to how the people should arrange to handle it, and I remember that his instructions were about as follows: Where the consumer had a large tank near the river, as most sugarhouses have, and was in the habit of gravitating the oil from the storage tank to the suction tank, he told them that they must put in a large pipe between those two, and put a pump and boiler at the storage tank, with heating coils in the storage tank, and force that oil from the storage tank to the suction tank, as it would not flow by gravity in cold weather. He said also that they should provide compressed air from some source, and when they shut down, particularly in the winter, they must blow all the oil out of the pipe line with compressed air, because if it froze on a cold day they would not get it started again. That surprised me very much, and for the first time I appreciated that they were furnishing us a semi-solid instead of a real liquid fuel.

PROFESSOR GREGORY CONSIDERS STEAM ATOMIZATION MORE SATISFACTORY THAN AIR

W. B. GREGORY. Professor Williamson has suggested the use of compressed air as an atomizer. In the pumping plant of the Neches Canal, near Beaumont, Texas, they first used steam as an atomizer, and then later installed a Connersville blower and thoroughly tried out burners with air as an atomizer. Whether the work was handled with great skill and intelligence I do not know, but I do know that they abandoned the use of air after some months of trial, and have ever since used steam instead. I think that in general, and for stationary plants at least, steam has been found by experiment to be far more satisfactory than air.

MR. DUSENBURY ENDORSES OIL AS FUEL

ALLEN T. DUSENBURY.[1] Our plants are scattered about through the waterways of South Louisiana, and we can handle oil to much greater advantage than we can coal. For small pumping plants, if I order a carload of coal and take it to the plant, sometimes it will last a year or more, but the deterioration in the common line of coal is very great; whereas with a carload of oil, you put it in a tank and you may keep it indefinitely. For that reason alone, for our work, and also in getting fuel oil to the dredgeboats, it has been very convenient, and I would be willing to pay a considerable premium to get oil rather than coal for the purposes for which I have need of fuel.

THE AUTHOR GIVES HIS CLOSURE

B. S. NELSON. In regard to the handling of heavy fuels, it may be stated as a general rule that heavy oils have to be

[1] Louisiana Meadows Co., New Orleans, La.

heated every time they are moved through a pipe. Assuming the case of an ordinary plant which gets its oil in tank cars, if the plant is so located that the tank car reaches the plant within a day after it leaves the refinery, it will usually be found warm enough to run out by gravity, as the oil is well heated when it is put into the tank car. In case the oil is too cold to run out by gravity, every tank car is fitted with heating coils, and a steam connection should be provided at the unloading switch to connect to these coils. A ½-in. or ¾-in. steam line is usually ample to heat up the oil in the tank.

As to precautions to render storage of oil safe, most of the oil now burned is of such high flash point that there is very little danger of gas accumulating. The curves in Fig. 1 give the flash points of various oils. However, any one can find the information required on this point in a new book entitled Fire Prevention and Protection, Rules for the Safe Storage of Oil.[1] Aside from insurance requirements, it is well to always keep the oil tank closed and have a vent pipe extending up out of danger from sparks or matches. Where oil storage is particularly dangerous, as on shipboard or barges, it is well to provide the storage tank with a large live-steam smothering connection, the function of which is to cover the oil with steam and so exclude the air. The refineries which have in the past suffered large loss from lightning setting their tanks afire now use an ingenious method of extinguishing fire by the use of foam made by pumping simultaneously to the top of the tanks two liquids which, when mixed, produce a heavy foam, which blankets the surface of the oil, thus excluding the air and extinguishing the fire.

With reference to the burner mentioned by Mr. Burwell, one reason that type is not used more is because it operates on the mechanical-atomizer principle, and the characteristic of it is high oil temperature and high pressure. I have seen cases where oil was heated as high as 240 deg. and carried 240 lb. of pressure on it. It is used a good deal in the Navy, but the oil has to be heated to such a high temperature and carry such a high pressure that it makes it dangerous. The burner used is a round-flame burner, usually, and requires forced draft, though in the naval vessels they use forced draft in any case.

The mechanical burner has been tried in stationary furnaces. Mr. Lockett and I did a little work on a mechanical flat-flame burner, but we did not get very far. A burner of that kind would be a desirable thing. Most of the mechanical burners depend on centrifugal force, and the oil comes out at the end of the burner as a diverging radial spray, and it is thrown out in a mist, which means that you get a round flame.

The average amount of steam used by the burner, to atomize the oil, depends on a good many things, for instance, whether the boiler is being run at full capacity or at part capacity. For a good burner, working under favorable conditions, you should not use over 1½ to 2 per cent of the steam generated by the boiler to atomize the fuel. With a poor burner, you may use 8 or 10 per cent. I have heard of some using as high as 15 per cent. The highest I ever got on a burner was 7 or 8 per cent.

With regard to the quantity of air required in the burning of oil, we figure on about 250 cu. ft. to a pound of oil, allowing for excess.

The manganese ore used in this country in the manufacture of ferromanganese has been hitherto mainly secured from three principal sources; viz., Russia (southern), India (southern British), and Brazil (east central). For a large number of years these three countries have outranked all other producing countries in the output of manganese ores. For the five years preceding the European war, Russia produced annually about 844,000 long tons, India 694,000 long tons, and Brazil 200,000 long tons.

The history of the manufacture of ferromanganese in the United States dates from the outbreak of the European war, summer of 1914. It appears that in no other substance entering intimately into the manufacture of steel have the war and the conditions brought about thereby produced such a radical effect upon domestic production and demand as in ferromanganese. The war itself, and coincident industrial activities, showed clearly the dependence of American steel makers upon European sources to furnish an adequate supply of one of the most essential ingredients in steel-making processes. Nor was there any vital reason for this, other than the excuse that foreign ferromanganese was cheap and abundant and prior to 1914 there was no indication that the supply would ever be cut off. As in the dye industry, this indicates the alarming improvidence of American manufacturers. England and, in a lesser degree, Germany, who have furnished the greater part of the ferromanganese used in this country, have made the alloy from imported ores, coming from Russia, India, and Brazil. It appears, in the light of the developments of the past two years, that the manufacture of ferromanganese on a commercial scale has come to be an important domestic industry, but it will remain so only so long as we have an abundant supply of ores. The closer trade relations which have been secured with South American countries seem to indicate that the greater portion of our manganese ore will come from Brazil in the future.—*Journal of the Franklin Institute*, May, 1917.

Pres. George W. Dunham of the S.A.E. and his collaborators have presented arguments that it is entirely feasible through the proper use of tractors to furnish any quantity of small grains that may be required for the world's food supply. Even with the 35,000 tractors now available the production may be materially increased by furnishing operators and Government supervision of the use of the tractors.

The present manufacturing equipment of the country is capable of producing at least 75,000 tractors a year under Government aid, and these additional tractors are estimated to be capable of cultivating in one year sufficient land to produce 1,000,000,000 bushels of small grain.

As regards farm labor, it is said that one man with a tractor can accomplish more than two men with horses. This makes the labor problem involved in securing an increased yield relatively less serious with tractors than with animal power.

The Bureau of Standards is undertaking to compile the present state of knowledge and practice concerning the numerical values used by engineers and others for the properties of metals and alloys, with a view to making generally available the most acceptable values of these constants and also as a basis for further experimental investigation. A form sheet is furnished containing the various items required. These cover the mechanical, thermal, electrical, and optical properties of value to the investigator and engineer. A sheet of instructions for compiling the table—with an illustrative filled-out form for commercial electrolytic copper—is included. This contains a list of the alloys on which data are particularly desired.

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[1] Spectator Company, New York.

BY-PRODUCT COKE AND COKING OPERATIONS

By C. J. RAMSBURG [1] AND F. W. SPERR,[2] JR., PITTSBURGH, PA.

ON JANUARY 1, 1915, there were in operation 6438 by-product recovery ovens of various sizes in the United States and Canada, having a capacity to carbonize 24,000,000 tons of coal per annum, and to produce therefrom approximately 18,800,000 tons of coke. Despite the fact that in the interim practically five hundred ovens have been discarded, on January 1, 1918, there will be in operation, if present contracts are completed, 9900 ovens, having a capacity to carbonize 47,400,000 tons per annum, giving a coke production of 35,000,000 tons. In this three-year period by-product coke production will have practically doubled, and there will have been as much gain in capacity as in the previous twenty years.

The cause of this rapid increase has not been a desire to take advantage of the inflated prices for by-products due to war conditions, but a financial condition favoring large investments brought about by the war, and making it possible to carry forward plans made previously.

The most impressive fact is the conservation of our local supply brought about by the introduction of modern methods. It may be of interest to make a few calculations simply from the standpoint of *fuel values;* and to put the matter on the most conservative basis possible, let us figure such values in terms of coal.

Table 1 shows a total fuel saving of 825 lb. of coal per ton of furnace coke. The fuel value of the gas is put as against raw *coal,* B.t.u. for B.t.u. There is a further saving in the blast furnace of 200 lb. of coke per ton of beehive coke formerly used. Figured back on a coal basis, these 200 lb. of coke represent 282½ lb. of coal at the beehive oven, so that the total saving amounts to approximately 1100 lb. of coal—0.55 ton—for each ton of by-product coke made in the modern plant. Since the ovens added from January 1, 1915, to 1918 will produce practically 16,200,000 tons of coke per annum, it follows that they will save annually the fuel equivalent of 9,000,000 tons of coal.

Looking backward over the years consumed in bringing the coke oven to its present stage of development in America, there are some events which stand out preëminently. The first of these dates back to 1906. In that year the United States Steel Corporation was brought face to face with the necessity of formulating a definite policy as to its coke supply, and appointed a committee to study beehive coking and by-product coking and to make a recommendation to the company. The advice of this committee was quickly acted upon by the corporation in the decision to build a by-product oven plant at Joliet, Ill., in connection with the blast furnace and steel plant of the Illinois Steel Company, and to build that type of oven which they had found to give the most efficient results in European countries.

The success of this Joliet plant was so immediate that the corporation without delay proceeded with the construction of additional plants of the same type, including the largest by-product coke plant in the world at Gary, Ind., consisting of 560 Koppers ovens, and a plant of approximately the same size as the Joliet plant (280 ovens) at Ensley, Ala., for the Tennessee Coal, Iron, and Railroad Company.

The second event was the selection of silica material for one of the oven batteries at Joliet. The value of the silica in this connection is due to four characteristics.

TABLE 1 BY-PRODUCT YIELDS FROM COAL SUCH AS NOW USED TO MAKE FIRST-CLASS BY-PRODUCT COKE IN THE MIDDLE STATES DISTRICT

85 PER CENT HIGH VOLATILE, 15 PER CENT LOW VOLATILE

		Fuel value equivalent, lb. of coal
To make 1 Ton Furnace Coke, 1.4 to 1.5 Tons Coal are Required. By beehive coking, the by-products wasted have a heat value equivalent to 625 lb. of coal.	*Surplus Gas. 9000 cu. ft., 550 B.t.u. Used as fuel.*	330
	Tar. 12 gallons. Used to make creosote oil, pitch, lampblack, various oils and dye materials.	133
	Ammonium Sulphate. 33 lb. (or, in form of 25 per cent ammonia liquor *33 lb.*). Used for fertilizer, for refrigeration, and for nitric acid and other chemical manufactures.	(*No fuel equivalent*)
	Benzols (as light oil). *4.5 gallons.* Used for motor fuel, dye-material base, phenol and other chemical manufacture, solvent and cleanser.	42
	Coke Breeze. 120 lb. Used as fuel.	100
	Total	625
	Add coal equivalent wasted in beehive oven	200
	Total economy of by-product oven per ton coke	825

1 The conductivity at high temperatures is superior to that of clay brick

2 The fusing or softening temperature is much higher than that of fireclay

3 The action under heat may be calculated with scientific exactness, due to its practically constant composition

4 The expansion and contraction of silica material between 2000 and 2600 deg. fahr. is practically negligible, so that when the material has once been heated to within this temperature range (under which condition the coking operations are conducted) no further appreciable movement takes place.

The third event was the realization that with uniform heat distribution in the ovens and with the use of silica material much higher heats and consequent higher coking velocities could be employed, and, further, that, with the lower coking periods, higher volatile coals could be used, with increased yields of by-products and equally satisfactory coke.

The result can be demonstrated by the fact that the Joliet plant of the United States Steel Corporation, put into operation in 1908, was originally planned to use from 70 to 80 per cent of low-volatile coal, and the coking time was figured at 24 hours. A coke plant of 640 ovens, now building at Clairton, Pa., near Pittsburgh, is so designed that it may be operated on 15 hours' coking time and is expected to use 100 per cent high-volatile coal. Even if this does not make quite as

[1] Second Vice-President, The H. Koppers Company.

[2] Chief Chemist, The H. Koppers Company.

Abstract of paper presented at a joint meeting of The Franklin Institute and the Philadelphia Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, February 1, 1917.

high-grade furnace coke as the coke at Joliet, its use will work out on broad lines to better purpose, and time will tell where the comparison lies after opportunity has been given the furnace operators to adjust themselves to the new type of coke.

The effect on the products can best be shown by reference to Table 2.

TABLE 2 YIELDS OF BY-PRODUCTS PER TON OF COKE

	Coal Mixture A 80 per cent low volatile 20 per cent high volatile	*Coal Mixture B* 100 per cent high volatile
Tar	6.5 gal.	13.5 gal.
Ammonium sulphate	23.3 lb.	38.0 lb.
Surplus gas (debenzolized)	7500 cu. ft.	10,000 cu. ft.
B.t.u. per cu. ft. gas	500	560
Total B.t.u. in surplus gas	3,750,000	5,600,000
Light oil (benzols)	2.6 gal.	5.4 gal.

A comparison in value of by-products on a basis of normal values shows a credit per ton of furnace coke of approximately $1.25 in favor of the high-volatile coal.

The fourth event was the awakening to the fact that, while an increase in the cubical content of an oven tends to a reduction in plant cost and in operating labor due to handling larger units, a decrease in oven width would more than offset this unit-size advantage because of absolutely different conditions.

The reason for this becomes apparent with an understanding of the factors involved. Increased length of oven gives increased cubical content, and the ultimate economic length depends upon the mechanical and structural limits. Of increased height the same may be said, except that this involves questions of time of contact of volatile products and speed of their flow which modify the advantage and which are yet to be finally worked out.

Increased *oven width* involves an entirely different consideration. Practically all the heat supplied for the coking of the coal mass flows from the two walls toward the center. This flow of heat depends to a large extent on the resistance and temperature, and in the coke oven the average rate of coking depends, of course, on the rate of heat penetration. For example, it becomes apparent at once, in a comparison between a 16-in. oven and a 20-in. oven, that the following is true:

a With the same temperature of wall the average velocity of coking in the 20-in. oven will be less than in the 16-in. oven, and the time required to coke the 20-in. oven will be more than proportionally greater than the 16-in. oven

b To coke the 20-in. oven in the same time as the 16-in. oven, the wall temperature must be increased very markedly

c To coke the coal in the two ovens at the same average rate, the wall of the wider oven must be considerably hotter than that of the narrower one

d With the *same wall temperatures*, more coke can be made per day in the narrower oven than in the wide one

e To make the same amount of coke per day, the wall temperature in the 16-in. oven would be lower.

Four points are of great value in this connection:

1 Overcoked material is of less value in a furnace than a greener coke

2 The wider the oven the more overcoked the outside layers will be and the larger the proportion of overcoked material for a given output

3 The production of by-products is enhanced by reducing the wall temperatures

4 The life of oven brickwork is increased by being operated at lower temperatures.

The result of this reasoning was the decision, in 1914, to reduce the width of oven from 19¾ in., average then being built, to 18¼ in.

Plants of the reduced width are now in operation as follows:

	Ovens
Toledo Furnace Company	94
Youngstown Sheet and Tube Company	204
United Furnace Company	47
River Furnace Company	204

There is no doubt among those who have been acquainted with the wider ovens that the narrower oven has the following distinct advantages:

1 Less sponge in the coke

2 Better coke from the same coal

3 As good coke from higher volatile mixtures

4 Higher yields of tar, ammonia, and benzols

5 Low temperatures for the same coking velocity.

The fifth event in coke-oven development is the universal recovery of benzols. The war furnished the primary inducement to developing this phase of the industry; but the fact that the material might be disposed of advantageously for motor fuel after the demand for explosives would cease had an important bearing in stabilizing the large investments demanded.

Previous to the war comparatively few plants were equipped for benzol recovery; in fact, outside the plants of the Semet Solvay Company, operated for their own account, there was comparatively little benzol extracted, and this was used, for the most part, in enriching illuminating gas. Today practically every coke-oven plant in America has installed this recovery, and the production in 1917 will be in excess of 40,000,000 gal., rated as light oil, if continued at the present rate.

While the removal of benzol reduces the heat units in the gas, the loss in this manner is a very small factor, and the return to be secured from the sale of this product is likely to be greater than that secured from the recovery of tar.

One feature of the benzol credit as related to motor fuel is the smallness of the quantity compared with gasoline production, and, since benzol and gasoline are miscible, the utility of benzol will be enhanced by increasing the quantities available.

Experiments recently conducted by a large oil company on its trucks and passenger automobiles proved that not only is benzol more valuable than gasoline as a motor fuel when used straight, but its effective value is increased by being mixed with gasoline. While these experiments are not complete, nevertheless they indicate that a mixture of equal parts of gasoline and benzol gives a value over 16 per cent greater that that of straight gasoline, which shows 32 per cent increased value for the benzol half. In 1917 there will be produced in this country over 1,000,000,000 gal. of gasoline, so, while the value of benzol is stabilized, for this reason it cannot be a very great factor in the motor-fuel situation. Every means should be taken not only to secure additional quantities from a standpoint of *preparedness*, but from a standpoint of motor-fuel supply.

In connection with the value of benzol as a motor fuel there is an interesting fact which may in the future have a very marked influence. In many quarters alcohol is looked upon as the ultimate fuel, but it cannot be employed except with less efficiency and with greater difficulties, due to its high

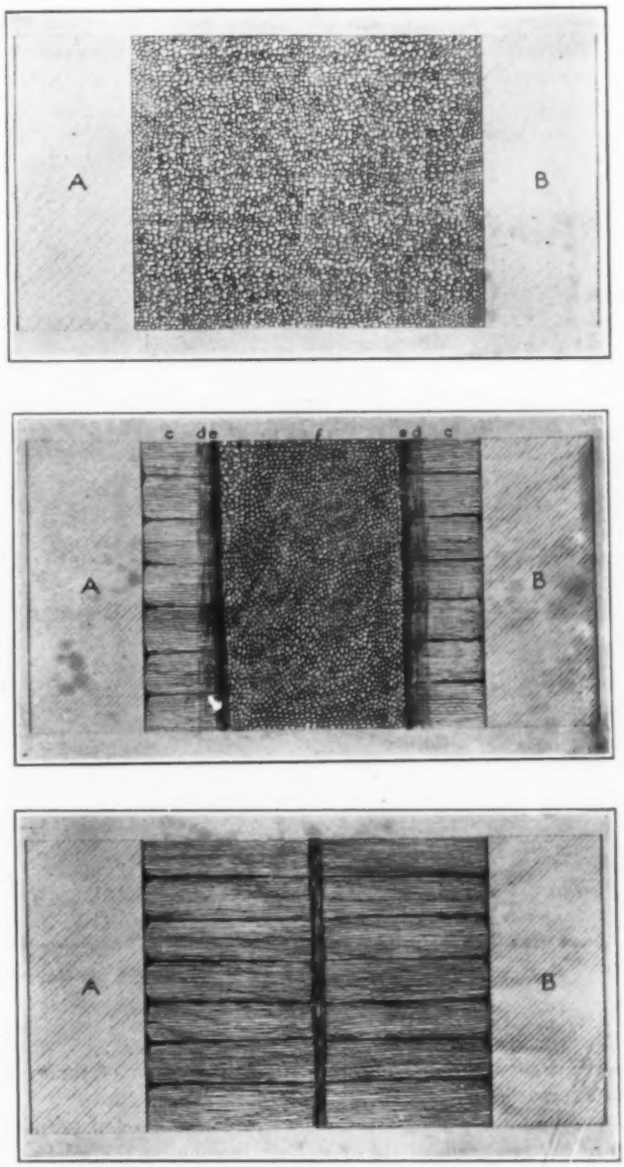
hydrogen content. Commercial alcohol and gasoline are not miscible. Alcohol and benzol are miscible and make a most efficient fuel, and, further, *after the addition of benzol to alcohol* the mixture will carry quite a high proportion of gasoline. The future may see benzol as the tie between gasoline and alcohol, permitting a piecing-out of the gasoline supply and an introduction of alcohol as a commercial motor fuel.

Taking up in somewhat more detail the study of by-product coke and its use in blast furnaces, the phenomenal growth of the by-product industry has stimulated a renewed interest in the main product. This interest is due, first, to the recent revolutionizing of ideas regarding the relative values of by-product and beehive coke. The tardy recognition of the fact that by-product coke of a fairly wide range of origin, when properly used in the blast furnace, gives results not merely as good as, but much *superior* to, those obtained from beehive coke, was accompanied by a realization that the limit of efficiency had by no means been reached; that Grüner's "ideal performance"— long the *ne plus ultra* of blast-furnace men —was actually being surpassed by many blast furnaces, and that much regarding the question of coke economy still remained to be learned. In the renewed study of the subject that this realization is just beginning to stimulate, we have the inestimable advantage that the by-product coke plants are being located in proximity to, and usually under the same management as, the blast furnaces that they are intended to supply, instead of at the coal mines as was the case with the beehive ovens. Thus the blast-furnace operator knows better the sources of the material that he has to use and the conditions under which it was produced, while the coke-plant operator can more intelligently regulate the performance of his ovens and the quality of his product, according to the requirements of the furnace. Above all, the combination and coöperation of the two plants result in a regularity of performance that is perhaps more to be desired than any specific quality of material. It is to be hoped that this coöperation may soon be extended to the foundry and other industries using coke as fuel.

It will assist in following the few descriptive studies of coke that we have to present, to give a brief account of the generally accepted theory of the coking process. The development of this theory is due to several German investigators, notably Much,[1] Hilgenstock,[2] Rau,[3] and Simmersbach,[4] and it has received such abundant confirmation from every practical standpoint that there can be no question of its soundness.

Let Fig 1 represent a section across a by-product coke oven immediately after the charge of coal is introduced. The layer of coal next to each wall *A* and *B* is very rapidly heated. A complicated process of destructive distillation begins, and at a temperature of about 375 to 400 deg. cent. the layer becomes soft and pasty. The pasty mass is for a while in a state of violent ebullition, due to the rapid expulsion of its volatile matter, and then rapidly solidifies, the indurated residue retaining the vesicular form and structure of the pasty, foaming stage.

The adjacent layer toward the interior has in the meantime reached the pasty stage, the fusion being assisted by the penetration of some of the soft material forced over from the outer layer. The gases and vapors follow always the line of least resistance and pass through the porous outer layer and up along the wall of the oven instead of forcing their way through the viscous inner portion of the fused layer, and then through the mass of coal. In passing through the highly heated porous layer, the hydrocarbons undergo a partial secondary decomposition, depositing part of their carbon on the cellular surfaces just formed, thus building up and strengthening the coke. The coking process is thus to be conceived as involving



FIGS. 1 TO 3 DIAGRAM OF THE COKING PROCESS

the formation of a fused zone, and the gradual advance of this zone toward the center of the oven, the evolved gases and vapors depositing part of their carbon in the vesicular mass left as the zone progresses. The condition of the material in the oven when the coking has fairly well advanced may be represented by Fig. 2: *c* is the portion already coked, *d* is the fused zone merging into an adjacent zone *e*, which, being in a state of incipient fusion, is more viscous; *f* is the uncoked coal.

The actual thickness of the fused zone is probably not over ½ in. The drop of temperature across this narrow zone is very great, and the interior of the oven remains compara-

[1] Chemie der Steinkohle.

[2] Journal für Gasbeleuchtung, vol. 45. (1902), p. 617.

[3] Stahl und Eisen, 1910, p. 1240.

[4] Grundlagen der Kokschemie, Berlin, Julius Springer, 1914.

tively cool, even at an advanced stage in the coking process. Simmersbach's experiments[1] on a Koppers oven of 500 mm. (19⅞ in.) mean width, operating on 29 hours' coking time with a final maximum temperature of 1120 deg. cent., showed that the temperature in the middle of the oven, 1 meter above the floor, remained about 10 deg. cent. for 2.5 hours after charging; then rose to 100 deg. cent., and remained at this temperature until 13 hours after charging. At 20 hours the temperature was only 410 deg. cent.

The rate of advance of the two zones toward the center of the oven depends principally upon the temperature of the walls *A* and *B*. In present practice, with ovens 18 in. wide and wall temperatures about 1000 deg. cent., the average rate is about ½ in. per hour. The initial rate is, however, much more rapid than this, and decreases as the center of the oven is approached.

FIG. 4 COKE IN BY-PRODUCT OVEN JUST AFTER REMOVING DOOR

As the coking progresses, cracks or joints develop perpendicular to the walls of the oven, thus determining the blocks of coke as they are eventually formed when the oven is discharged. These cracks form avenues of escape for a large percentage of the gases, hence the amount of deposited carbon is greater in proportion on the surfaces of the blocks than in the interior. Eventually the two zones merge at the center of the oven (Fig. 3), and, with the practically complete expulsion of the last of the volatile matter, the coking process is finished. There is always a distinct parting in the center of the oven, so that the length of the blocks is equivalent to about half the width of the oven. Fig. 4 shows a view of the coke as it appears when the door of the oven is removed. Most of the coke immediately adjacent to the walls of the oven is covered with a skin of carbonized pitch. The true form of the blocks may be seen in a few places where this has been broken away.

[1] Stahl und Eisen, June 14, 1914, p. 954.

FIG. 5 BLAST-FURNACE COKE, ATLANTIC DISTRICT

Fig. 5 shows a view of a typical coke. In this figure the individual blocks may be seen distinctly. A few characteristic blocks are shown in Fig. 6. The three smaller pieces in this figure are cross-sections. The end of the block (Fig. 7) originally adjacent to the wall of the oven may always be distinguished by its cauliflower-like appearance and dense layers of deposited carbon. We shall designate it as the wall end and shall call the other extremity the center end, for want of a better term. The structure of the coke toward the center end is always more open, and occasionally is somewhat spongy.

The shape of the coke is quite characteristic, depending upon the coal from which it is produced, and also, to a considerable extent, upon the method of heat treatment. The coke-oven man classes his product as either *blocky* or *fingery*, coke of the former character being preferred. Some typically fingery coke is shown in Fig. 8. As a rule, the coke from coals of over 30 per cent volatile matter is apt to have a fingery tendency—and this becomes highly pronounced if the coal has a high oxygen content. By coking such coals very slowly at temperatures somewhat lower than used in ordinary practice, the fingery tendency may be disguised or in many cases entirely eliminated. By disguising it, we mean that the product will actually appear to form large, massive blocks,

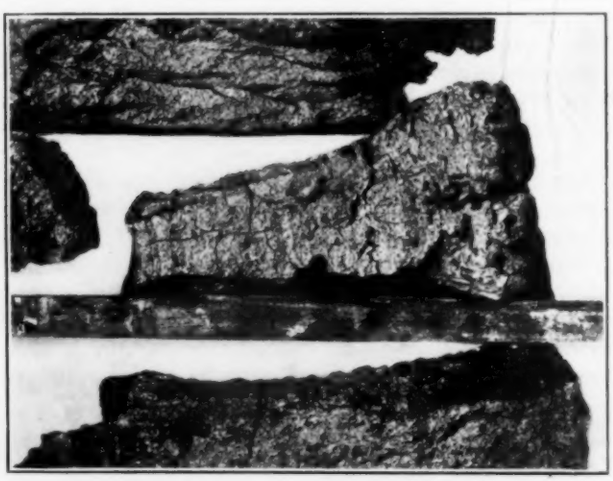


FIG. 6 TYPICAL BY-PRODUCT COKE

but these blocks, if closely examined, will be found actually to be bundles of slender pieces more or less firmly cemented together. However, if the heat treatment be very carefully regulated during the coking process—especially in ovens designed and adapted to this particular type of coals—genuine, firm, blocky coke may be made from many coals usually regarded as producing only the fingery variety.

The size of the blocks is affected to a certain extent by almost all the conditions pertaining to the manufacture of coke. The length is, of course, dependent upon the width of the oven, the average being, on account of shrinkage, a little less than half the width of the oven. The blocks from the top of the oven are usually (especially with high-volatile coals) shorter than those from the bottom. Overcoking and high temperatures tend to produce small-sized coke.

Coming now to an examination of the natural surfaces of the blocks, we may, in the first place, disregard the color as being relatively unimportant. It depends largely upon the method of quenching, and, to some extent, on the quality of the water used, the use of large amounts of water causing a dark color, while with the careful use of a minimum quantity of water a light gray color can always be preserved. The majority of cokes produced from the standard coking coals rich in hydrocarbons and low in oxygen have close-textured, even surfaces, with possibly a few narrow, transverse zones of slightly larger cell openings interspersed between the two extremities. Many cokes from coals of the Connellsville (Pa.) type show the same silvery, glossy skin that used to be so much prized in beehive coke. This is probably indicative of a very heavy deposit of carbon, especially favored by slow and uniform evolution of a very rich gas.

Other cokes fully equal in value to the above are characterized by a peculiar shaggy appearance, as if they were covered with blotches of dark moss. This appearance is usually found in cokes produced from mixtures of eastern coking coals with the somewhat more highly oxygenated coals of the central field. Oddly enough, both types of coal usually make smooth coke if carbonized separately.

Certain cokes present transverse pebbly seams—usually not more than two or three. These seams are very narrow and quite coherent, and may be shown to be composed of small globules of quite pure carbon, with no apparent cellular structure. This phenomenon again appears to be characteristic of the more highly oxygenated coals.

The surfaces always show more or less transverse and longitudinal cracks, significantly at right angles—either parallel or perpendicular to the wall of the oven. Naturally these are an element of weakness, and their presence to an excessive degree is one of the surest "first-hand" indications of an inferior grade of coke that we have. The amount of fracturing can be controlled to a surprising extent by proper methods of heat treatment.

By breaking a piece of coke and examining the fresh surfaces we find revealed the cellular structure that is characteristic of all cokes and which cannot be seen in its true development simply by inspecting the dense natural surfaces. No definition of coke is complete that does not take this cellular structure into account.

The usual way—and the easiest—to examine the cell structure is to break a piece of coke crosswise and note the appearance of the fresh surfaces. Great care must, however, be taken, in comparing one coke with another by this method, to break the pieces at approximately the same distance from the wall end, since the cells are apt to increase considerably in size from the wall to the center. Oddly enough, in many cokes there is a characteristic difference in the two surfaces of a break. No matter where the piece is fractured, the surface on the wall side has always a granular appearance, with a steel-gray luster and well-defined cell openings. The opposite surface (*i.e.*, looking toward the center of the oven) has a characteristic graphitic luster, with the cell openings flatter and possibly not so sharply defined.

Although this difference is rather hard to depict photo-

FIG. 7 WALL END OF A BLOCK OF COKE

FIG. 8 FINGERY COKE AND SPONGE (COLORADO COAL)

graphically in a satisfactory manner, we have attempted to do so in Figs. 9 and 10, which will also show the variation of the sizes of cells from wall and to center. The sections have been made with a 1/16-in. emery wheel at 2, 4, and 6 in. from the wall end of one block of coke. (This is a standard blast-furnace coke made from a mixture of West Virginia and Pennsylvania coals, and is the same as shown in Fig. 13.)

For any accurate comparison of the cell structure of different cokes we prefer to make longitudinal sections with a thin emery wheel—such sections as are shown in Figs. 12 to 17. If this is done, the danger of confusing sections made at different distances from the wall will be largely eliminated. It must be mentioned that *breaking* a piece of coke longitudinally so as to reveal the real cell structure is a decidedly difficult matter. Almost always the break will be found to be made along the plane of a natural longitudinal fracture.

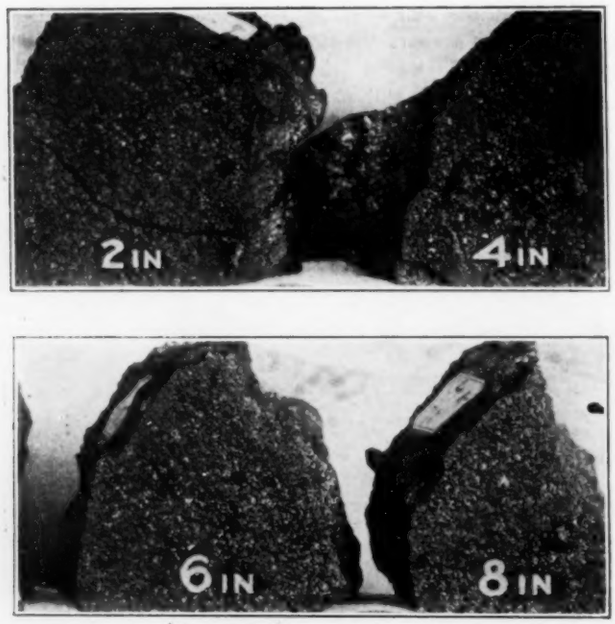


FIG. 9 CROSS-SECTIONS OF COKE SHOWING SURFACES TOWARD CENTER
(At marked distances from wall)

and the exposed surfaces will be found to be covered with deposited carbon.

Great importance has been attributed to the cell structure of coke by all authorities on the subject, and especially by blast-furnace operators, and yet the subject is very poorly defined and no standards of comparison have been established. We have recently begun the use of a simple system, analogous to the scale of hardness used in the study of metals, which we hope may come into general favor. At present we employ a set of four standards, shown in Fig. 11. These are all longitudinal sections, cut from blocks of typically different cokes.

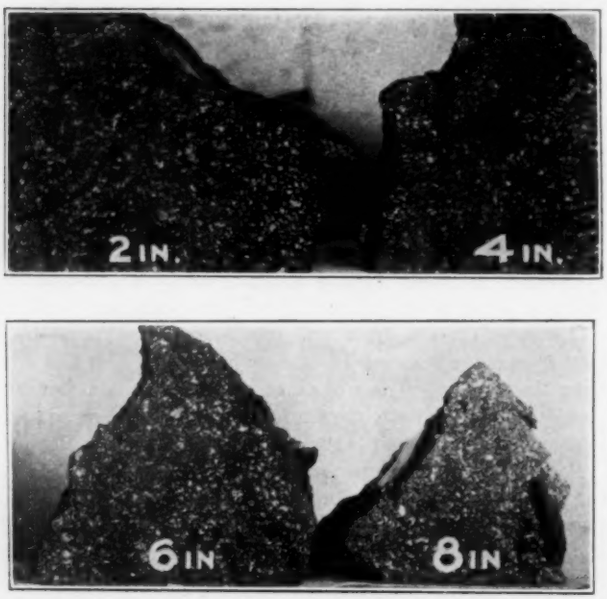


FIG. 10 CROSS-SECTIONS OF COKE SHOWING SURFACES FACING TOWARD WALL
(At marked distances from wall)

The sections are the same length, and each is cut beginning $1\frac{1}{2}$ in. from the wall end. The sections are numbered 1 to 4 in order of increasing cell size. With such a set of standards it is easy to grade any coke according to its cell structure, and the grading will convey a much more definite idea than the loose terms of "dense," "close," "rather close," "fairly open," "medium," etc., hitherto used.

In addition to grading cokes according to size of cells, we may also classify them as regular or irregular in cell structure. The standards would all be considered as regular in structure. This does not mean at all that the cells are of the same size,

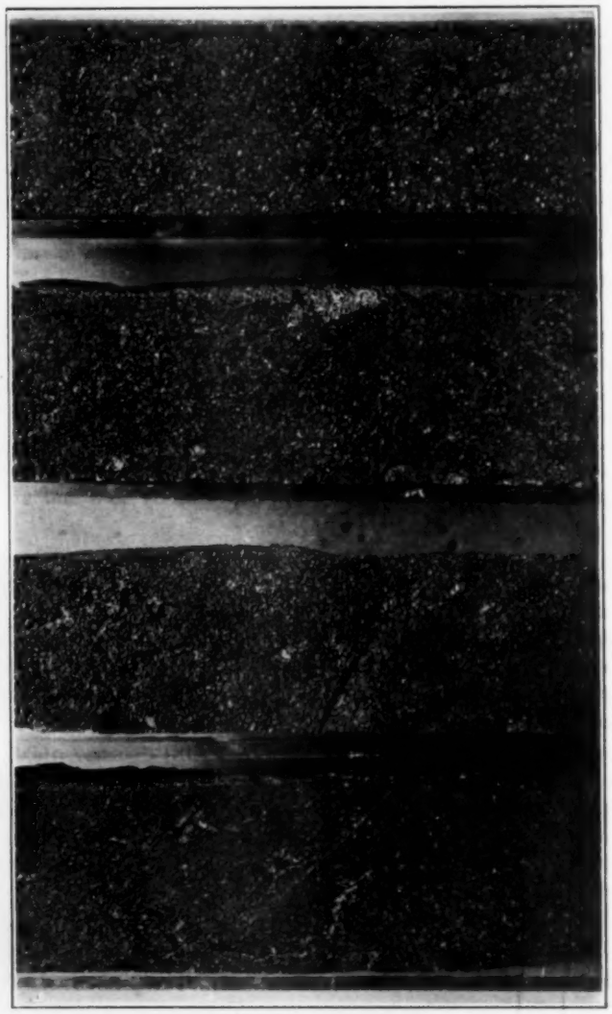


FIG. 11 STANDARDS FOR GAGING CELL STRUCTURE
(No. 1 at bottom; No. 4 at top)

but their general arrangement gives an easily perceived impression of regularity. What we mean by irregular structure is illustrated by the sections shown in Fig. 12. This sort of coke has alternate patches of close and open texture, and is frequently produced by the more highly oxygenated class of coking coals, as well as by mixtures of coals having decidedly different characteristics.

It might possibly be thought now that an interesting table could be prepared grading the cell structure of cokes produced from various typical coals. Such a table would be well-nigh valueless unless the data were carefully qualified by details regarding preliminary treatment of each coal, dimensions of ovens, temperatures, coking time, and several other

factors, each of which plays a part in the development of cell structure. It may be more profitable to show a few sections of different cokes that have given successful results in blast-furnace and foundry practice in various parts of the country. Figs. 12 to 17, inclusive, illustrate some specimens carefully selected to be as representative as possible.

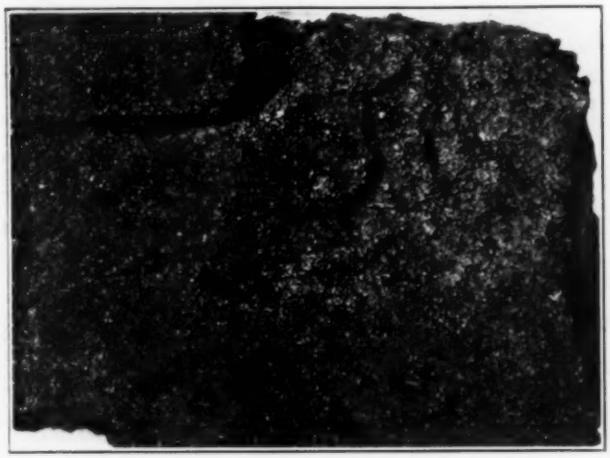


FIG. 12 COKE FROM ELKHORN COAL, WITH 35 PER CENT POCAHONTAS

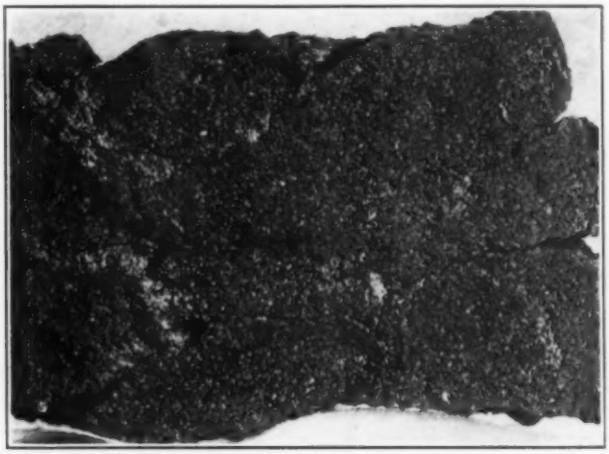


FIG. 15 COKE FROM KENTUCKY COAL, WITH 15 PER CENT POCAHONTAS

FIG. 13 COKE FROM MIXTURE OF PENNSYLVANIA AND WEST VIRGINIA COALS

FIG. 16 COKE FROM PITTSBURGH COAL, WITH 20 PER CENT POCAHONTAS

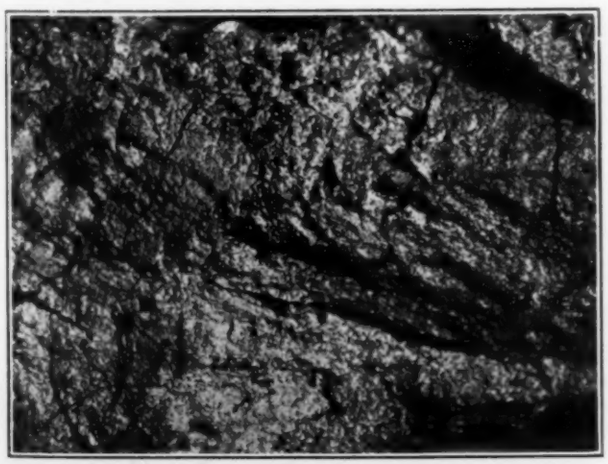


FIG. 14 COKE FROM ALABAMA COALS

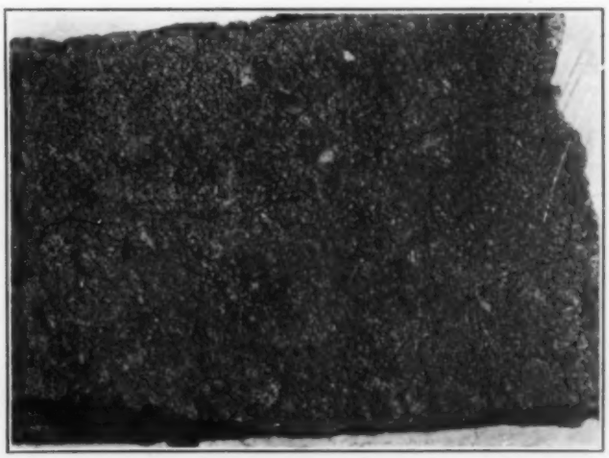


FIG. 17 COKE FROM PITTSBURGH COAL, WITH 40 PER CENT POCAHONTAS

Sometimes too much reliance is placed in the determination of the specific gravity and porosity of coke. Figures as to

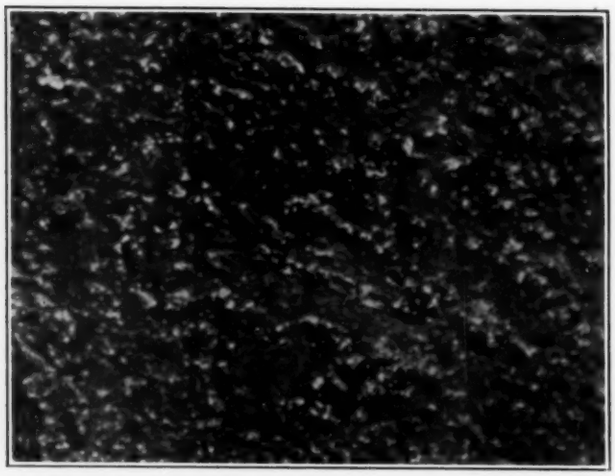


FIG. 18 STANDARD NO. 1 ENLARGED 10 DIAMETERS

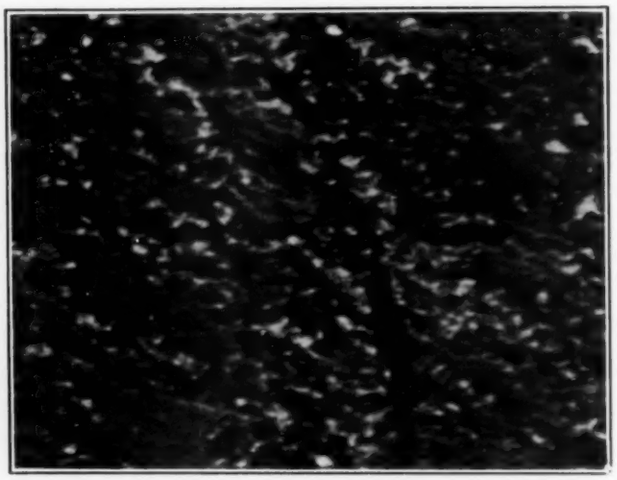


FIG. 19 STANDARD NO. 2 ENLARGED 10 DIAMETERS

porosity or the percentage of cell space in the total volume of coke are almost valueless unless supplemented by an examination of the actual size of cells and thickness of cell walls. A coke of close texture and thin walls may have the same percentage of cell space as one having large cells and relatively thick walls. As John Fulton[1] the pioneer investigator of coke, said, 34 years ago: "Mere cellular space . . . cannot be used as an element in the practical determination of the value of cokes for blast-furnace use. Furnace gases cannot act on cell spaces; they can only act on exposed surfaces." It is the cell walls and surfaces that are the most important. Cell space and porosity, which is the measure of it, are merely incidental.

Table 3, which gives the specific gravities and porosities of coke specimens, will show that there is really no relation between cell structure and porosity.

For ordinary purposes in grading cell structure magnification is unnecessary. Photographic enlargement gives some interesting information as to the character of the cell walls. Figs. 18, 19, 20 and 21 show portions of standards Nos. 1, 2, 3, and 4, respectively, each enlarged 10 times. There is considerable apparent irregularity of cell diameter, due to the fact that the cells are cut in different planes, but the comparison of the four types of coke is fairly good.

In passing from this subject of the examination of coke sections we would take occasion to point out the interesting field

TABLE 3 SPECIFIC GRAVITIES AND POROSITIES OF COKE SPECIMENS

Cell grading	Figure	Apparent specific gravity	True specific gravity	Porosity
1 (Standard)	11	1.097	1.917	42.8
1		0.924	2.006	53.7
1.5	12	0.974	1.891	48.5
2 (Standard)	11	1.007	2.028	50.4
2	14	1.138	1.948	41.6
2.5		0.857	1.979	56.7
3 (Standard)	11	1.071	1.831	41.6
3	16	1.053	1.917	45.1
3	17	0.854	1.862	54.1
4 (Standard)	11	0.943	1.988	52.6
4	13	0.943	1.988	52.6
4	15	0.917	1.921	52.3

open here for the application of petrographic methods to an exhaustive investigation of the material. The actual chemical and physical state of the carbon produced from various coals under various conditions is an important matter from a practical standpoint. Differences in the true specific gravity of coke are frequently found that cannot be explained by varia-

[1] Bull. Am. Inst. Min. Eng., October, 1883.

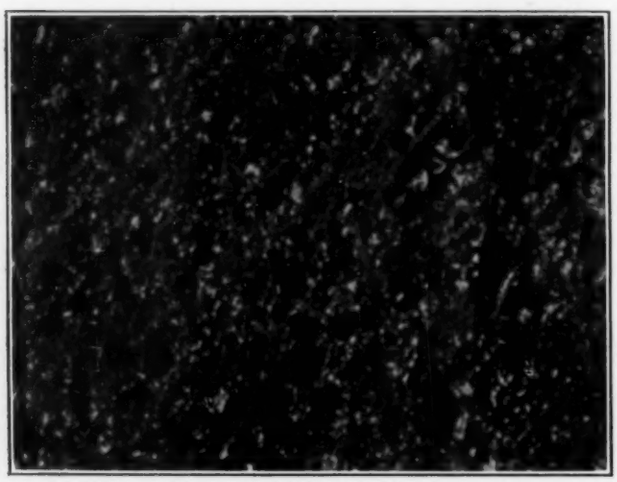


FIG. 20 STANDARD NO. 3 ENLARGED 10 DIAMETERS

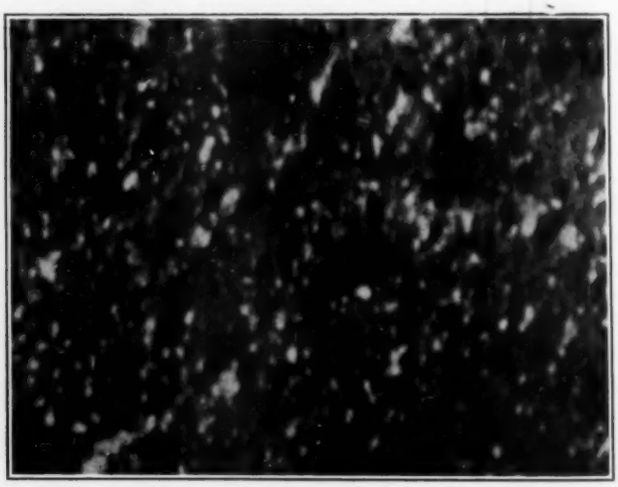


FIG. 21 STANDARD NO. 4 ENLARGED 10 DIAMETERS

tion in the content of inorganic matter. The actual condition of this inorganic matter after carbonization, the amount of reduction of the various oxides, the possible effect of the finely disseminated mineral matter in strengthening or weakening the cell walls are all very important. Inorganic matter does not necessarily constitute an element of weakness. Large particles, especially if segregated, are injurious, but finely divided mineral matter may actually strengthen the cell walls. High-ash cokes are frequently stronger than low-ash cokes from the same kind of coal. Some experiments in washing and coking coals of moderate ash content have shown that where the original coal gave a strong coke, the washed coal gave a weaker coke, the difference being undoubtedly due, to some extent, to the removal of some of the mineral matter, although the high moisture content of the washed coal might have had some effect. Simmersbach gives some evidence to show that iron present in combination with carbon and silicon, and silicon present as a silicon carbide, may be the cause of the remarkable hardness of some coke.

Studies of this character will, however, be largely of academic interest unless correlated with studies of the behavior of different types of coke in the blast furnace and in other types of apparatus in which the material is used. Let us choose the blast furnace for consideration here on account of its tremendous industrial importance.

There is at present some disagreement among blast-furnace men as to the exact function of the coke in the most efficient and economical reduction of iron ore. The majority probably still accept Grüner's theory of ideal working, viz. (as stated by Richards[1]), "All the carbon burnt in the furnace should first be oxidized at the tuyères to CO, and all reduction of oxides above the tuyères should be caused by CO, which thus becomes CO_2." It is well known that the reduction of iron oxide by carbon monoxide is the most efficient from the standpoint of heat economy. Richards, however, has pointed out that the direct reduction of iron oxide by carbon is three times as efficient from the standpoint of carbon required as the indirect reduction, and says:

"The ordinary furnace produces at the tuyères, in order to get heat enough to melt down the charges, more CO gas than is needed to abstract all the oxygen from the charges; under these conditions it is uneconomical to oxidize any carbon at all above the tuyères. The exceptional furnace, because of pure ores, small amount of slag, pure fuel, high temperature of blast, or dry blast, gives heat enough at the tuyères to melt down the charges without producing enough CO gas to reduce all the charges; under these conditions, more or less reduction is effected by solid carbon and with the greatest economy in quantity of carbon required in the furnace."

About a year ago H. P. Howland prepared an interesting paper,[2] entitled Calculations With Reference to the Use of Carbon in Modern American Blast Furnaces, calling attention to the fact that many furnaces are actually operating with higher economy of coke than would be calculated from Grüner's theory; in fact, his calculations on the performance of 26 furnaces seem to show that what Richards regarded as the exceptional furnace is the rule rather than the exception in modern practice.

Howland's tabulation of data on these 26 furnaces is so interesting and pertinent to the subject that a portion of it is reproduced in Table 4.

Note incidentally the performance of the once-despised by-product coke in modern practice. Of the 19 furnaces using less than a ton of coke per ton of pig iron, 13 are burning by-product coke and 6 beehive coke.

Howland calculates that all the furnaces burning less than 1350 lb. of carbon at the tuyères are not making enough CO to reduce all the Fe_2O_3 and hence some of the latter must be reduced directly by carbon. He concludes: "It seems clear, therefore, that in low-coke furnaces one of the most important (if not the most important) functions of the carbon burned at the tuyères is to produce heat to enable the carrying on of the direct reduction, rather than to produce CO for indirect reduction.

"On this basis, it becomes very essential that our carbon shall burn instantaneously to CO in order that the resulting heat may be localized where needed. This should not be a question of seconds, but of a fraction of a second. If our carbon is of such a nature that this burning to CO is a comparatively long process, more of it will be required than of the quick-burning carbon in order to obtain the same concentration of heat at the desired point.

"We would, therefore, say that the most desirable thing about a coke is that quality in the carbon which will allow of its being instantaneously burned to CO and thus result in the maximum concentration of heat where needed."

W. H. Blauvelt, in a discussion of Howland's paper,[3] says: "In studying the combustion of coke in the furnace, it is clear that the production of the maximum quantity of heat is not of the first importance in blast-furnace operation, or in the utilization of the fuel charged into the furnace. To my mind, the production of a high thermal head at the tuyères is of the first importance, and the best coke is that which reaches the tuyères in proper condition to produce the highest temperature at the tuyères, and in just sufficient quantity to do the amount of work required there under the conditions produced by this

TABLE 4 PART OF HOWLAND'S DATA ON AMERICAN BLAST FURNACES

Furnace No.	Pounds coke per ton iron	Tons iron per day	Carbon in coke, per cent	Kind of method of manufacture	Coke operation	Total charged	Gasified in furnace	Gasified at tuyères	Per cent total carbon	Per cent gasified carbon
1	2,615	301	86.3	BH	Stonega	2,254	2110	1868	82.8	....
2	2,551	272	84.4	BP	Solvay	2,153	2049	1751	81.4	86.6
3	2,472	482	86.1	BH	Conn.	2,128	1996	1728	81.2	86.8
4	2,247	450	87.1	BH	Conn.	1,957	1846	1605	82.0	87.0
5	2,198	499	86.9	BH	Conn.	1,908	1810	1494	78.7	82.6
6	2,123	541	88.3	BH	Conn.	1,875	1764	1498	79.8	84.9
7	2,115	360	84.3	BP	Solvay	1,782	1683	1427	80.1	84.8
8	1,996	490	86.3	BP	Koppers	1,722	1611	1298	75.4	80.6
9	1,936	376	85.7	BP	Solvay	1,659	1557	1305	78.8	83.7
10	1,905	393	88.7	BP	Solvay	1,690	1575	1252	74.1	79.5
11	1,901	517	85.5	BP	Koppers	1,625	1524	1280	78.8	84.1
12	1,863	504	86.6	BP	Koppers	1,614	1513	1230	76.2	81.3
13	1,780	426	84.9	BP	Koppers	1,511	1414	1124	74.4	79.5
14	1,742	503	84.6	BP	Koppers	1,474	1382	1133	76.9	82.0
15	1,716	542	87.1	BH	Benham	1,494	1396	1194	80.0	87.0
16	1,715	585	84.6	BP	Koppers	1,451	1357	1114	76.6	82.2
17	1,702	543	87.5	BP	Koppers	1,490	1388	1130	75.9	81.5
18	1,699	572	87.0	BP	Koppers	1,479	1387	1155	78.2	83.4
19	1,673	580	88.6	BH	Benham	1,482	1384	1182	79.9	85.0
20	1,658	590	88.3	BH	Benham	1,464	1366	1182	80.8	86.5
21	1,636	442	89.5	BP	Koppers	1,463	1369	1124	76.8	82.1
22	1,635	593	88.5	BH	Benham	1,447	1349	1124	77.7	83.4
23	1,624	592	87.3	BH	Benham	1,447	1317	1118	79.0	85.0
24	1,623	457	89.6	BP	Koppers	1,454	1360	1090	75.0	80.2
25	1,589	608	88.3	BH	Benham	1,403	1307	1100	78.5	84.2
26	1,584	466	89.2	BP	Koppers	1,413	1324	1057	74.8	79.9

NOTE—BH = Beehive. BP = By-product. Conn. = Connellsville.

[1] Metallurgical and Chemical Calculations, p. 248.

[2] Bull. Am. Inst. Min. Eng., March, 1916, p. 627.

[3] Bull. Am. Inst. Min. Eng., October, 1916.

FIG. 22 COKE FROM STRAIGHT HIGH-VOLATILE COAL, SHOWING SPONGE

FIG. 23 COKE FROM SAME COAL AS FIG. 22, WITH 20 PER CENT POCAHONTAS

maximum temperature. The combustion of a much larger amount of fuel at the tuyères, under conditions that will fall short of producing the highest possible temperature, cannot produce as good results, either in fuel economy or output. . . . Nothing is more fatal to obtaining the highest temperature than an excess of combustion. In the blast furnace an excess of air dilutes and cools the products of combustion, reducing the maximum thermal head at the tuyères, and the larger volume carries the high temperature zone too high in the furnace. . . . It will probably be generally admitted that furnace coke should be of nearly uniform size, and many furnace managers are eliminating all coke below ¾ in. and above 4 or 4½ in.; also, that the best coke is that which is sufficiently strong to resist undue abrasion and crumbling by attrition with the stock, and of an open porous structure that will permit the most rapid combustion when it reaches the tuyères. Many large users agree that the coke should never be overcoked beyond the point of producing a sufficiently strong structure, as overcoking quickly reduces the combustibility.

"If Grüner's ideal gives the best furnace operation, we should want a coke that is resistant to the oxygen in the ore, but easily combustible at the tuyères, which is a contradiction of qualities. If my argument is correct, that the furnace man wants the greatest thermal head at the tuyères rather than the production of the greatest quantity of heat in the furnace as a whole, then he is willing to sacrifice some coke by solution in the oxidizing gases in the upper part of the furnace, provided he can obtain a sufficient quantity of coke at the tuyères, of a quality that will permit rapid combustion with the minimum amount of air, thereby giving him the maximum thermal head."

The desirability of the condition which Blauvelt aptly terms *a high thermal head* in the zone of the tuyères will be readily granted even by those who adhere to Grüner's theory. This condition should be attained even at a sacrifice of some carbon by solution loss ($CO_2 + C = 2CO$), and we are of the opinion that the importance of this solution loss is frequently overestimated. Most laboratory experiments made to determine the loss undergone by different cokes have been of little value, because they have been mostly made with pulverized samples, so that their original physical condition has been greatly altered.

We have lately tested the resistance of a number of cokes to the action of CO_2 at temperatures of 800 and 900 deg., and find the loss of coke pulverized to 40 mesh to be very much greater than the same coke prepared in small test pieces, ⅜ in. by ⅜ in. by 1½ in., so as to retain the original structure.

As furnace conditions are better understood, the possibility

FIG. 24 COKE FROM COLORADO COAL, SHOWING SPONGE

FIG. 25 COKE FROM SAME COAL AS FIG. 24, PROPERLY MADE

of the use of coke of a wider instead of a more restricted range of quality will become better recognized, with the express limitation that the supply for each furnace must always be absolutely uniform in quality. This requirement of uniformity cannot be too strongly emphasized, and it is almost equally necessary for the proper operation of the coke plant as the blast furnace; but this does not mean that there is one standard grade of coke to which all plants should conform so far as possible. As a matter of fact, the range of cokes that successfully qualify in practical operation is continually being extended, through necessity of one sort or another, with little general realization of the fact. In Figs. 12 to 17 we have already shown the cell structure of some cokes that are giving good results in different American blast furnaces, and the difference is fairly remarkable.

However, for each kind of coke there is evidently some limiting size for efficient service, i. e., just large enough to offer such a minimum surface of attack for CO_2 that the loss on this account is negligible, and small enough so that complete combustion may be effected in a minimum of time at the tuyères. Hardness of body is usually—though possibly not necessarily—proportional to the resistance of a given coke to oxidation by CO_2 or oxygen. The harder grades of coke should be used in smaller sizes—and this is a compensation automatically provided to some extent by the operation of the by-product oven. Similarly, cokes of close cell structure are more resistant to oxidation, but this may be offset to a large extent by softness. The coke of more open cell structure will probably require less rigid attention to sizing than the denser coke. The important thing is to determine the practical limits of these elements of size, hardness, and cell structure. It may be found that a coke of such structure as No. 1 of our scale may be unsuitable, no matter what may be its size or softness; but this ought to be proved by actual test and not taken for granted.

These considerations are of the utmost importance and encouragement to the coke-oven man, because, with a reasonable choice of coal, his control over the quality of his coke is almost unlimited, and, even with a very restricted source of supply, the possibilities of conforming to the desired standard by proper oven construction and regulation are still remarkably great. We propose to conclude this paper by showing two or three examples of what can be accomplished in the way of control of this sort.

One proposition that frequently presents itself is that of eliminating sponge. Sponge is a characteristic honeycombed mass formed in the center of rich volatile matter. It seems to be caused by an excess of pitchy material moving along with the fused zone in the coking process, and finally accumulating in the center of the oven, where it is eventually gasified, with the production of this light porous material. Sometimes this sponge is found in loose, detached masses scattered all over the coke as it lies on the wharf after quenching, or, again, it may be found adhering very closely to the ends of the pieces of coke, and sometimes blending, without any clear line of demarcation, into the body of the coke itself.

Although the amount of this sponge often appears to be very large, it is so bulky that its actual percentage by weight is small. In one case where the amount of sponge seemed to be very large it was actually found that it amounted to 1.65 per cent of the total coke. Small amounts of sponge probably do no harm, most of the material being soon broken up in the operations of handling the coke, but the presence of the material undoubtedly occasions a certain loss of carbon, and so we usually try to get rid of it. The customary remedy—and one that always works—is to mix with the high-volatile coal sufficient low-volatile coal, which has the effect of absorbing the excess of bituminous material and eliminating the conditions of sponge formation. Pocahontas coal is the standard low-volatile coal that is employed by many of our plants. It is to be noted that different coals require considerably different percentages of Pocahontas coal to completely eliminate the sponge. Fig. 22 shows a coke from unmixed high-volatile coal (about 34 per cent volatile matter). A large amount of sponge is readily apparent. Fig. 23 shows the coal from a mixture containing 80 per cent of this same coal with 20 per cent of Pocahontas. The sponge is entirely eliminated and the structure of the coke improved.

Frequently it is too expensive a proposition to buy low-volatile coal for the sake of eliminating a little sponge, and

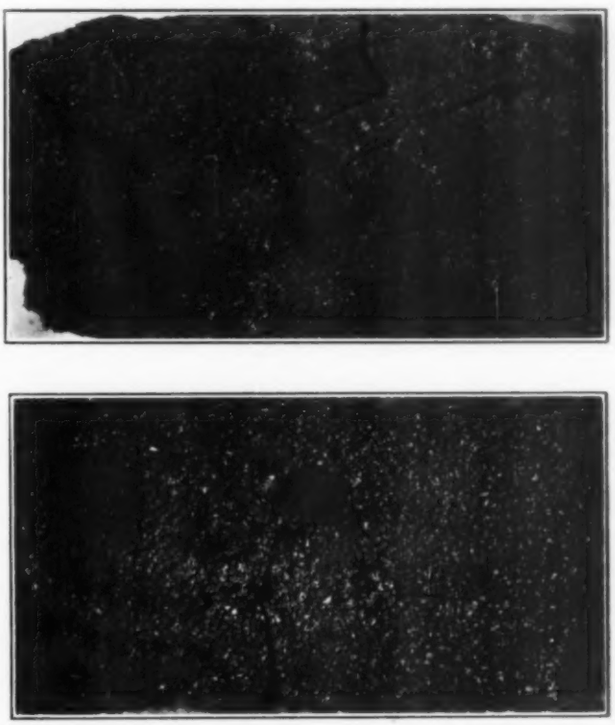


FIG. 26 SAME COAL MIXTURE COKED AT DIFFERENT PLANTS UNDER DIFFERENT CONDITIONS

sometimes the low-volatile coal may be altogether inaccessible for practical purposes. This does not, however, leave us at the end of our resources. By proper methods of control, sponge may be eliminated from a wide variety of coals that produce it under ordinary conditions. If the oven is correctly designed and proportioned, and the temperature and coking time carefully regulated, very satisfactory results may be obtained without the necessity of making a special coal mixture. Fig. 24 shows the coke from one coal which was made in a type of oven unsuited to it, and coked at unfavorable temperatures. Fig. 25 shows coke made from the same coal under proper conditions. The sponge has been entirely eliminated.

Occasionally one of the most difficult problems to be overcome is that of too great density of cell structure. Here, again, we can approach the problem in two ways: one, by mixing in one or more other coals that have a tendency to the production of a more open cell structure, and the other way by suitable preliminary preparation of the coal, careful heat

control, and special design of the oven. Fig. 26 shows coke made from the same coal mixture coked at different plants under different conditions. The dense coke shown in the lower part of the figure was greatly improved upon when the nature of the coal was better understood, and the excellent product shown in the upper part of the figure was then made when the coal was treated in the right kind of ovens and under proper conditions.

To insure the best results a special study must be made of each kind of coal it is proposed to use, and it would be well, in all cases where a new plant is contemplated, to make this study previous to design of the plant, because the results may suggest some necessary changes in design that would not otherwise be foreseen.

Technical Education in Great Britain[1]

IN THE early days of our Institution most engineers were trained entirely in the shops. Theoretical knowledge was uncalled for, and even held to be antagonistic to practical success. There was no supply of scientific engineers. It was only in 1840 that the chair of engineering was established at Glasgow University. There were engineering courses in London at King's College, and courses dealing more particularly with mining and shipbuilding at the School of Mines and at the School of Naval Architecture. In the provinces there were a few technical colleges. It was not till 1877 that the livery companies of London appointed a committee to consider a national scheme of technical education. The City and Guilds Central College was the result. Then came the appointment of the Royal Commission, which reported in 1884, the formation of the National Association for the Promotion of Technical Education in 1887, and the Technical Education Act of 1889, which refused to the schools it governed the means of teaching the practice of any trade. In 1890 only was a real foundation laid by the transfer of the control of technical education from the school boards to the local authorities.

The result has been a vast expenditure on technical schools, ranging from the technical school of the small borough to institutions of university rank like the Municipal School of Technology in Manchester. Besides these we have provided engineering courses in most of our older universities, and endowed new ones. To Oxford, Cambridge, St. Andrews, Glasgow, Aberdeen, Edinburgh, Dublin, Durham, London, we have added Manchester, Wales, Birmingham, Liverpool, Leeds, Sheffield, Bristol, Belfast, and the National University of Ireland.

With all these schools and colleges, the problem of educating engineers and engineering workmen has not been solved. Our innate conservatism ties us too much to traditions. Many still fail to understand that the manual training which enabled an apprentice to become a master craftsman does not suffice to turn a schoolboy into an engineer. Moreover, differentiation is needed in training. Designers and scientific advisers require a knowledge and experience which managers and business organizers can forego, etc. This lack of differentiation seems to be one cause of the inefficiency of our technical education. Another certainly is insufficient preparation of those entering the technical schools.

The education available for the higher ranks seems fairly satisfactory; at all events, it has produced men capable of solving many problems presented by the war. I would give one caution and make one complaint. There are many Englishmen of the best type with initiative, ability to organize, etc., but incapable of assimilating much book learning, especially higher mathematics. Do not let us force these men through the same collegiate course as men of different mentality, but keep them to more elementary work and require a high standard in examination. We must not underrate these men. Many of them are of our very best. The Institution recognizes their value by admitting them without examination at 30 years of age.

My complaint is against retaining Greek as a compulsory subject at Oxford and Cambridge Universities.

The education provided for the workmen is most unsatisfactory. Trade apprentices who enter the shops at 14 years of age seldom have subsequent opportunities for learning other than at evening classes. I have seen in some paper that technical education in England and Wales is provided in 6,876 evening and similar schools, but that the average attendance is about one hour per week. The workman must have better education to qualify him to rise if capable, and to give those who have not the ability to rise some interests outside their daily work and football matches. Unless an antidote be provided, the monotony of repetition work will crush initiative and mental vigor, and instead of skillful workmen we shall breed incompetent machines.

The interests of engineers require two classes of institutions giving technical instruction, each with its definite purpose: (1) technical "colleges," (2) technical "schools" (senior and junior). The technical "colleges" should be of university rank, and should be departments or faculties of universities, like the Municipal School of Technology in Manchester, not independent of them, as in Germany. They should provide two courses, one for the scientific advisers and designers, the other for the managers and business organizers. They would receive their students mainly from the higher secondary schools. The gate should be opened only to those capable of profiting by the teaching. The idea of university education for the million is most pernicious nonsense. The technical "schools," both senior and junior, should also have two courses, one for men likely to become foremen or supervisors, the other for those likely to remain manual workers. These courses should not be purely technical. The schools would receive their students from the elementary and lower secondary schools. They should remain under the local authorities, so that the technical teaching might be varied in accordance with the local trades.

Another desideratum is coördination, especially between the higher secondary schools and the technical colleges, and between the elementary and lower secondary schools and the technical schools, so that pupils passing from the one to the other would be properly prepared for the change.

The U. S. Bureau of Mines has received an offer of the complete laboratories and working staffs of the Minnesota School of Mines, Minnesota Mines Experiment Station, New York State School of Clay Work and Ceramics, Department of Chemistry, University of Texas, University of Cincinnati, Department of Chemistry, Louisville University, State Board of Health Laboratory, Ohio State University, and the Johns Hopkins University.

Commercial and other laboratories have also offered their services, among them being the Mellon Institute for Industrial Research; the General Electric Company; the Central Testing Laboratory, New York; the Fuel Engineering Society, New York.

[1] From Presidential Address, Institution of Mechanical Engineers, April 20, 1917, by Michael Longridge.

PREPAREDNESS

By A. M. LOCKETT, NEW ORLEANS, LA.

Member of the Society

THE word *Preparedness* carries the idea of doing something in advance of an expected event in order that such event may be successful. Preparedness for the defense of the nation at a time of peace and with no immediate prospect of war is an abstract proposition which may be properly discussed as such. But when the nation is in a state of war, preparedness is no longer an abstract proposition but a condition which calls not for discussion but for *action*.

With this understanding of the proposition the subject becomes a question of not how we should prepare for a possible war but how we shall conduct a war which is now on our hands.

I have no technical knowledge to qualify me for advancing any views as to the manner in which military operations should be carried out. All that I can do is to give my personal views as to what I conceive to be the things which engineers can and should do to serve their country.

While it has always been the universal desire of the American people to avoid war, it certainly is also the intention of all Americans to win any war in which they are forced to engage.

It is useless now to waste time discussing the causes which led up to the war—the proposition before us is to discuss the ways and means of winning the war which is now beginning.

Many of us undertake work involving engineering design and construction varying in character and magnitude, but none of us has ever undertaken, or even conceived, of so large a contract as the American people are now called upon to execute.

This is not a job upon which we have the option of bidding or not bidding. The contract has been awarded to us and our certified check, which is nothing less than the sacred honor of our country, has been deposited and will be forfeited unless the job is successfully carried out.

The plans for this undertaking have been made by the Army and Navy. It is not for us, the American people, to find fault with these plans; our work is to carry them out with dispatch and completeness. The men who have made these plans have been trained from their boyhood in this line of work, and it would be foolish for us to assume that these plans are in any degree defective or incomplete. Therefore, the first duty in my opinion for all the people of this country is to get behind the Army and Navy and back them up to the absolute limit if we hope to execute the work successfully.

Every citizen of the United States is in theory, and in fact, in the service of the Government, whatever may be his occupation, or even if he has no occupation whatever. Every American citizen recognizes the obligation of coming to the defense of the nation in time of war, and if he is of sound mind he must know that such defense, to be effective, must be preceded by the necessary preparations.

In war patriotic fervor and enthusiasm play a prominent part, but the real work must be done by the men who have a clear understanding of the task, a full knowledge of the sacrifices to be made and a grim determination to carry out the program whatever the cost.

All men desire to win in any contest in which they engage. They may regard with equanimity the possibility of defeat when the penalty involves only loss of money or personal prestige, but when defeat involves loss of national integrity or national honor, no patriotic citizen can ever entertain the thought of defeat.

This being the case, any man who deliberately blocks or attempts to prevent the carrying out of any measure of preparedness which in any degree reduces the danger of defeat, is no more nor less than a traitor.

There may be differences of opinion as to whether a certain measure may in fact improve the chances of victory, but when all men agree that if certain things are done the probable outcome of this war is more to our advantage, to gamble upon the possibility of such measures not being needed is the height of folly.

It is fortunate for us in this emergency that we have had the opportunity to witness the practical demonstration which has been taking place in Europe for more than two years, because many theories previously advanced on the subject of military preparedness and national security have been proved untenable.

Germany has been able, by reason of the preliminary arrangements which we call Preparedness, to resist with marked success enemies many times more numerous, and it would be foolish for this country to fail to profit by her example in so far as practical preparations with respect to land operations are concerned. Likewise the British Navy has demonstrated that superiority of equipment is absolutely conclusive with respect to naval operations. We are confronted with a war which may involve both land and naval operations, and it is our duty to profit by what we have learned from these other great nations.

No comprehensive plan of preparedness can be carried out without the full coöperation of the whole people. The people will not back up any project which they do not believe sound in principle and necessary for the good of the country. There are some propositions involving merely economic policies upon which the people will take sides and follow leaders, more or less blindly, although they may not fully understand the principles involved; but when it comes to the question of war which calls for the sacrifice of all they hold dear, even to their lives, they must be roused not only to understand the necessity but they must have such a deep-seated conviction of the righteousness of the cause as they have in their religion.

It devolves upon us who are converted to convert those who have not yet seen the light, and one of the purposes of this paper is to attempt to point out the way the non-military engineers can assist in bringing the people to a proper understanding of the situation so that they will do what they should do.

In determining what is the duty of us engineers in this

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emergency I make the suggestion that we can serve in two capacities—one as ordinary citizens, having an equal part with other citizens in influencing the actions of Congress, and the other in the capacity of engineers having technical knowledge and practical experience in work closely allied to the operations of the military engineers.

I believe that as citizens we should take the lead in the campaign of converting the people in general to a full realization of the situation, because we are qualified by our training to gather together in intelligible shape the facts and figures bearing upon the subject and to present them to the public in a manner which may be more easily understood by the average citizen than if those same facts and figures were included in a more or less technical explanation such as would ordinarily be made by military engineers.

As I have already said, the people will not get behind this movement with the proper spirit unless they are thoroughly convinced, first, that the preparedness movement is sound in principle, and second, that the actual necessity now exists.

I take it that no man who has made any attempt to post himself regarding the actual condition of this country with respect to preparedness, denies that the country is not prepared to bring to a successful conclusion a war with a first-class power.

If there be any who have any doubt upon this subject, I refer them to the report of a board of officers and civilians made through the War Department to the U. S. Senate in the early part of January, this year. This committee consisted of three Army officers and two civilians appointed by Congress to investigate the subject of the feasibility, desirability, and practicability of the Government manufacturing arms, munitions, and equipment, and certain other allied questions.

This committee made examinations of all the Government arsenals and the principal private plants capable of manufacturing the class of articles required by the Army and Navy, held conferences with heads of leading industrial institutions, and through all practicable sources sought information not only upon the question of whether the Government could manufacture its own arms, munitions, and equipment, but secured accurate data as to the supply of such articles now on hand and the time necessary to secure such supplies from all sources in the case of an emergency.

The report of this committee is in much detail and is very complete.

What I gather from the facts brought out is as follows:

1 The various departments of the Government have on hand at the present time the necessary equipment only for the present regular army and the militia
2 That to properly equip an army of 500,000 men will require six months
3 To equip an army of 1,000,000 men will require one year
4 To equip an army of 2,000,000 men will require 18 months

These are facts and are not open to argument, and the thing for the American people to do is to accept them as facts and to act accordingly. Every military and naval authority allowed to express an opinion publicly has in the most unqualified terms testified in general, and in detail, to the fact that we are pitifully unprepared. If it requires six months to prepare the equipment for an army of 500,000 men, we must start now.

Every engineer ought to post himself as to the actual facts in this connection and use his very best efforts to convince the public in general of the absolute necessity of backing up the Army and Navy in their plans, and should bring such pressure to bear upon Congress that the necessary legislation shall be promptly passed. The great trouble with the people of this country is that they are suffering with that fatal complaint designated by Mr. Homer Lea as "the valor of ignorance."

The average American has the mistaken idea that one American soldier is equal to at least six soldiers of any other nation, when as a matter of fact six American soldiers insufficiently trained and improperly equipped would not be equal to one soldier of any other nation not handicapped by these deficiencies.

In olden times, when men fought hand-to-hand conflicts with various kinds of weapons, the strong and brave could easily conquer the weak, but in modern warfare battles are won by machinery and implements which can be handled only by men trained to a high degree, and personal bravery as well as physical strength go down in defeat when pitted against intelligence and experience armed with modern engines of war.

It is gratifying to be able to say that some very important steps have been taken toward national preparedness, and while up to the present time very little has been actually accomplished in the way of definite and positive results, we can, with some degree of truth, at least say that so far as the plans for mobilization of the great industries of the country for the backing up of the Army and Navy operations are concerned, they have been well prepared and the actual results will quickly follow if the proper coöperation is shown by Congress.

As all of you know, the engineers and chemists of the United States completed and delivered to the Naval Consulting Board on the first of September last, an inventory of the industrial resources of the United States.

As Chairman of the Board for the State of Louisiana I have been in close touch with this work, and I can say that while the information obtained was not as complete as was desired, it was sufficiently accurate to enable the Naval Consulting Board to formulate plans which, when carried out, will accomplish the purpose intended.

I desire to take this opportunity to express to the engineers of Louisiana, 144 of whom volunteered to assist, and did in fact give their time liberally to this work, that I believe it is quite probable we will again be called upon to do other work of this same character; and I hope that our efforts will be clothed with sufficient Governmental authority to require, where necessary, the industrial plants which show the disposition either to withhold information or to take the matter lightly, to answer all questions put up to them, the answers to which will be of value to the Government.

Now, coming down to the definite proposition of what you and I, as engineers, can and should do in the present emergency, it seems to me the first step for us to take is to furnish to the Government full information regarding our qualifications, and the Government should then point out to us the department of the Army or Navy to which our services should be offered.

DISCUSSION

COMMODORE V. S. NELSON. Last August, Congress passed an act establishing a naval reserve corps, which act was approved on the 29th of August, for the purpose of filling out the Navy, of expanding the Navy during time of war.

It seems that a great many people do not understand the difference between the Naval Reserve and the regular Navy. They do not understand what they have to do. When they enlist in the Navy, for instance, they agree to serve for four years. They are sent to sea immediately, and they have to stick out that full time. When they enroll in time of peace, they simply obligate themselves to enter the Navy in time of war. They leave their address with the commandant of the naval district in which they enroll, and they agree to come in for service whenever he calls for them, and he would not call for them unless the President had decided that a state of war, or some other national emergency, existed.

The man enrolling in the Naval Reserve in time of peace is not subject to the laws and regulations of the Navy, except during the time that he is on actual duty—in actual service. While it is the desire of the Navy Department that every man or officer enrolled should serve at least three weeks, they are enrolled for four years, and they are supposed to serve at least three months during that four years. The three months can be served in one year, or three weeks in each year, but in time of peace they are not compelled to serve at all. They simply agree to come in in case of war. But everybody believes that the people who enroll now will have to come in.

It is our object to get in as many men as possible. Of course, if the war lasts a short time, the people who enroll in the Naval Reserve will be allowed to go home and attend to their business, but as long as the war lasts they will be in the Navy, just as much as those people enlisted in the Navy.

Congress has established six classes in the Naval Reserve: The first class is composed of those officers and men who have been honorably discharged from the service, or who have resigned, or who have been discharged for other reasons; but the men who have been discharged must be American citizens. For the last ten or fifteen years nobody has been taken in the Navy except American citizens, but before that, there were some good men in the Navy who were not American citizens, and who received their honorable discharge, but they are not eligible to enroll now. They must be American citizens—take the oath of allegiance to the United States, and pass physical examination before a naval doctor who will be detailed for that duty.

The second class is known as the Naval Reserve—the first-class officers and men who have already served, and the second-class Naval Reserve, and that is composed of officers and men who have had experience at sea. A man to be enrolled as an officer must have had two years' service at sea, as an officer in a lake-going or sea-going vessel, and must pass a certain examination. He must also have had experience at sea, and must pass an examination in order to establish his rating. Officers are enlisted at ages from 21 to 35 years, and the men go in from 18 to 35 years. That is the second class.

The third class is the Naval Auxiliary Reserve. That class is composed of men and officers who are serving on American merchant vessels, who are suitable for naval purposes—naval auxiliaries in time of war, and they must have served, and must be serving, on board of ships of that class. Now, in order to secure a commission as an officer, a man must have, in some way, served on one of those ships, or be serving now, that is, to be enrolled in that class. The intention is not to make those officers enroll from those merchant vessels to serve in the regular navy unless they desire to do so, but to have these men who enroll for the auxiliary service serve in the same kind of ships that they have been serving in before they are enrolled.

The fourth class is what we call the Coast Defense Naval Reserve. This is composed of men who have not necessarily had any experience at sea, but who can be of some service to the Navy, either at sea or on shore. They could serve, for instance, in the coast-defense vessels, in scout vessels and in patrol vessels—the harbor patrol and the outside patrol—or they may serve as radio operators, paymasters, clerks ashore—almost any duty a man can perform will be of use to the Navy and will entitle him to enroll in this class.

Then we have the fifth class, which is composed of men in the flying corps. I don't think there is much flying done around here, but most of them have been taught in the naval schools, and these amateurs who have had experience are eligible as officers.

Then there is the class of volunteers who simply volunteer to come in in case of war. They don't have to come in and serve during peace times. But as we are now at war, everybody ought to be prepared to serve in some capacity or another.

It will take a great many men to man patrol boats, submarine chasers, and all these smaller boats in the coast-defense service. Take, for instance, this New Orleans district, which extends all the way from Tampa to the mouth of the Rio Grande. Patrol boats must be obtained to patrol that whole coast, and men have to be found to man those boats; and what we want to do as much as possible is to get men to enter the service—if they won't enter directly into the Navy, to enter into the reserve navy.

There will be a retainer paid every man and officer. They will get $12 a year, simply a nominal sum. Then, after three months' service, the men and the officers are given provisional appointment for the first time, until they have done three months' service. After that, the officers are examined by a board appointed by the Secretary of the Navy, and they are given the rank which they are qualified to fill, and then they receive a commission from the President and are regularly commissioned in the Naval Reserve. The men are examined in the same way, and rated in the rating which they are able to fill—as machinists, or firemen, or ordinary seamen, or whatever they can do, they are so graded. After they have been confirmed, that is, after they have done the three months' service, both the men and the officers, while they are on active duty, receive the same pay and allowances as the regular officers in the Navy, and the retainer pay in addition.

Now, of course, it is going to be necessary to find men to man all of these patrol boats, mine layers, mine planters, mine sweepers, to sweep for mines and protect the mines we plant ourselves—if it is necessary to plant any—and patrol the harbors, or the river here, and patrol all the coasts. We think that this section of the country certainly ought to provide men to help guard the coast on this side. Of course, New Orleans cannot do it all. All those sections along the coast ought to furnish men to patrol the coast.

MAJOR J. L. SCHLEY. I think the two things which Mr. Lockett brought out which are very, very important are, first, the work organizations, and second, a means of getting before the Government some method of procedure whereby they can get at the members of the organizations who are qualified to do certain kinds of work. Those are the two points which are most important for you to carry away with you. The first of those he mentioned in a way that would lead you to believe that a great many people are not cognizant of the facts as they exist today; that is, that we are unpre-

pared, and we are so badly unprepared that we have got to make haste quickly to get in proper shape. And the first thing, of course, to do is to persuade a man that this is a fact, and I think that probably an engineer takes things more in a matter-of-fact way and sees them as they exist better, probably, than members of other professions. In his daily work he meets with problems in which he must place on the one side the things which he has to build, to construct, and on the other side he is opposed by the laws of nature; and he knows that in order to accomplish something he must face those problems, and if anything goes wrong, the laws of nature, he knows, will come into play. For that reason, he brushes aside the unessentials, and usually arrives at a solution of the problem. Therefore, the engineers throughout the country have probably weighed the question on one side and the other, and have probably come to a conclusion in their own minds that something should be done, and each man has probably reached a conclusion more or less definitely as to what should be done. So I think the first point to be emphasized is that of convincing people who have not looked at things from our point of view of the actual conditions, and that something must be done and done promptly.

The second point of great value is to formulate the method of making it possible for the Government, as you might say, to put its finger on the individual and assign him to the work of a mechanic, or any other position to which he is especially adapted.

If each engineer should write personally to any one of the Government offices, for instance, the office of the Chief of Engineers, you can imagine what a mass of correspondence would be presented, and what a problem it would be to attempt to get anywhere with it; whereas, if an organization of this kind would, through a committee, get in touch with some one and present the names of men who are willing to do something in their particular lines, it would be very much more simple for the Department to assign some work to each group of men, or to each institution, or each organization. In other words, it is the difference between an organization and a mob. In a mob it is difficult to get hold of the individual, whereas in the well-organized army, or well-organized industry, through the different means of control and supervision, each man is assigned to the work which he can do best, and the results are to gather together to a common end, and I think that through your associations forming organizations for that purpose you can get in touch with the Government and the Government can get in touch with the individuals.

CAPTAIN H. A. DRUM. I appreciate very much the honor of being given this opportunity to carry out a duty which has been assigned to me. General Pershing has sent me to this part of his department in order to interest you in training camps. The training camp, as you are well aware, started in New York, about two years ago, through the patriotism and the individual realization of a national duty by a number of men in New York. It came to them suddenly that there was going to be a time when they would have to respond to their individual duty to the nation. They felt that when that time arrived they wanted to know something about the profession of soldiery. A few of them, about four hundred, gathered together and asked the regular Army to give them some of this training. That was based first on patriotism, second on an individual realization of a national duty.

Before taking up the details of the camp, I want to bring home one or two little points to you about the citizens' training. The President, in his message of December, 1914, stated that this country, in time of peril, should not depend on a standing army, or on a reserve army, but should depend upon a citizenry trained and accustomed to arms. If any of you will go back into our past history and study it carefully, you will find that has been our policy. If you go into the history of Europe and of other nations, you will find that has been the policy of the European nations. They have depended upon a citizenry accustomed to arms. This means a citizenry trained for and accustomed to the duty of defending the country. It cannot have any other meaning in a country like ours, in a country that is governed for the people and by the people. I don't see anything that can be more democratic than that the citizenry should defend the nation.

With these two thoughts in your minds, I would like you to think what your duty as a citizen of the nation is. I believe, first of all, your duty is to have adopted a policy of defending the nation for the people, of the people, and by the people. Second, if you agree to that, I think you should have a policy of having your Government train you for the defense of the nation. If one is true, the other is true also.

Certain civilians with whom I have talked about universal service have seemed to have the impression that the young man entered the service at about eighteen and stayed there until he was forty-five—spent his whole life in military service. That is not so. The General Staff Bill provides for one period of eleven months and three periods of two weeks each, practically a total of one year of actual service, except service in time of war.

This is nothing new to us, this conscription, this actual service by compulsion. In the Civil War we had it. The Confederacy adopted it in the first year of the war, and the North adopted it in 1862. If you analyze what universal service means, it is nothing more than producing a citizen army instead of a standing army. It is nothing more than having an army to defend your nation whose interests are peace, whose hopes are peace, and whose vote will be for peace as long as, in their judgment, the nation's honor and duty are safeguarded. It seems to me that it is the most democratic thing that you could have. It seems to me that it brings the rich and poor, capital and labor, on the same level in the defense of the nation. It brings them down to a common level of duty, and is the production of an army of the people, for the people, and by the people.

As to the past, we have never as a nation been prepared for any war, principally because the people of the nation have never made it their business to look into it. We are a democracy, and the basis of all democracy, the essence of democracy, is that movements shall start from the bottom and work up; that is, they will start from the people; whereas in an autocracy it is the opposite; they start from the top and are imposed on the nation below. The United States, except in one case, has never carried a war to a conclusion in which it has not had to use at least two men to the enemy's one. In the Revolutionary War we employed, all told, 395,000 men. The enemy had a total in this country of 150,000. In the War of 1812 we passed through our ranks 575,000 men; the total force of the enemy in this country was 67,000. In the Mexican War we had 140,000 men; the total Mexican force was 46,000. In the Civil War the North employed a little over two and a half millions, and the South a million. It seems to me that the marked difference in the numbers and the success on both sides in that war was due to the early adoption of conscription by the South. The only exception was the Spanish-American War, in which we had under

arms 280,000 men. There were, all told, in the Spanish forces—not in this country, but in the whole forces—not over 220,000.

If you will look back in the history of the Navy you will see that the Navy has been successful all through. It has had very few reverses, first and foremost because it has been an absolute Federal force. It has nothing to do with the forty-eight subordinate Governments. Second, it has had practically the same officers, the same skilled men in peace as in war. The expansion of the Navy for war is generally from the bottom.

The fine, large preparedness movement all over this country stirred people in an industrial way, worked up mobilization of tools, materials and all that, but it lacked one thing. Have you heard of any organization being formed for the mobilization of the fighting man-power of the country? Have you joined any organization for producing the fighting man-power of the country? There is where we have fallen down. It certainly is essential that we work on the production of munitions and mobilization of the industrial forces of our country. But there is one essential element and that is the fighting man.

We are now called upon to organize an army of a million men, and will need from 30,000 to 40,000 officers. We have today in the army a little over 8000. Where are we going to get the others? You cannot go ahead and organize an army without first having officers, and you cannot pick officers off the trees any more than you can pick engineers off the trees. You have to have men who have the fundamentals of education, whose brains have been developed in such a way that they are receptive and can pick up something new, work on it and get something tangible out of it. The point has been brought up here as to what the engineer can do. It is not a question of all of you staying home and working up the industries—the majority of you should get into that society of the fighting man-power and prepare to be officers. And the means for training men to be officers are these training camps. So the regular Army has put itself at the disposal of the citizens, to give you everything there is in us, and try to make you into the best officers you can be in the short time that we have.

Now, I claim that that disposition on our part throws a duty on you. Your duty is to come or to send some one to us, and we give you everything we have if you will come there to receive the training. These camps are primarily for the infantry. After that, they are for the training of every other branch of the service—cavalry, artillery, signal corps, and engineer corps. The medical corps have their training in these camps too. So if you want to start in the same line in which you have started your civil profession you can get your training in these military camps as a starter. The camps are free. There is no expense about them. The Government furnishes your transportation from your home to the camp, furnishes your food and uniform and equipment while at the camp. The only requirement is that you will deposit, on arrival at the camp, $10 as guarantee for the return of the equipment that the Government furnishes you. You are authorized to buy your uniform, according to the regulation standards, and the Government will reimburse you at the rate of one-third of the cost for each camp that you attend. The uniform will cost you about $15. One camp lasts for thirty days. The only obligation that you have to take upon yourself is an oath of enrollment, that you will serve the President of the United States and the officers over you during the thirty days of instruction at the camp. The camp which you go to is designated in the oath. After those thirty days are over, you are through.

LIEUTENANT E. S. MOSES. A few days ago Mr. Lockett was talking to Commodore Nelson, and he was very anxious to find some definite points that the engineers could start on, for work. So I wrote a few notes for Mr. Lockett, and I didn't expect to speak tonight; I thought he would bring that out. The first point was: start at once intensive training for young men who are ready to go ahead with actual preparedness but do not wish to bind themselves until they have maturely determined the work for which they are best fitted.

The second point was this: study facilities for a motor-boat repair base at the mouth of the river and the personnel for same. Also a supply system for boats operating at the mouth of the river—fuel, food and stores, as well as plans for medical attention. No doubt the Quarantine Station can furnish the personnel, but the Red Cross can probably aid with special equipment or nurses. Accommodations may have to be enlarged and provision made for taking care of people suffering from exposure in open boats.

I understand it will take several motor boats to form a scouting ring around the mouth of the river, and if there is anything sunk out there we will need large facilities for repair work and hospital work, and also in order to keep a steady chain of supplies going.

Third, thoroughly canvass aero resources. If practicable, have the Country Club finance as many aeroplane instructors as can be obtained and have as many members as possible qualify as air pilots. My suggestion of the Country Club is only for illustration, but I consider it practical for some group of wealthy men or women to start such a movement, and its immense importance is obvious.

You all know the relation of supply and demand of people who can operate aeroplanes and man aeroplanes. We can make the aeroplanes, but we cannot make our pilots.

Now, the next point that is particularly interesting to engineers—and to any wholesale dealers and manufacturers here—is to establish and maintain a perpetual stock-card system, showing the material actually on hand and ready for immediate delivery. This is a large order, but its benefit to the city under normal conditions would be so great that it is well worth while to press the matter in the present emergency, both as a patriotic measure and as an economical advantage to the city, so that the local dealers will get their share of war business. The Association of Commerce should be able to handle this.

The next point is developing a transportation system for immediate delivery of material. At the time of writing, a case is brought to my attention of material ordered from the stock of a local firm seven days ago, which is yet undelivered. The large volume of business now being done at the Naval Station would seem to justify the city dealers in coöperating by having a large motor truck leave the corner of Canal and Camp Streets at 9:00 a. m. and 1 p. m. daily, call at each of the dealers subscribing to its maintenance, and thence to the Navy Yard. This is only a suggestion of one of the thousands of details of rapid transportation which must be solved now that we are at war. I suggest the appointment of local transportation committees to devise some means of transporting stores and men from one place to another.

The concluding paragraph in my letter to Mr. Lockett is this: "I presume your Committee has gone very thoroughly into the question of increasing the production capacity of the

plants now in existence, and that you have gone into the question of assigning to individual plants constant production repeat orders in order to reduce the variety of work in jobbing plants. An efficient organization should be formed to control output so that there will not be an excess of one product and a scarcity of another equally important. I doubt if it will be practicable to exercise the necessary authority over individual plants by any private combination, but much advance work can be done to plan a scheme of control should it become necessary for the Government to take over all plants. The question of standardizing gages, fixtures, etc., comes under this general head, and if it is at all practicable I think it would be well worth while to call in the service of an efficiency engineer to make a general industrial survey."

GENERAL A. PERILLIAT. The talks we have had this evening from gentlemen who are well posted in their professions in the art of war have shown how much is to be done, and I fear how much is to be done very quickly, and at once. All of us knew that there was a gigantic work in front of us, but these gentlemen who belong to the profession of the soldier have thrown a little additional light on how much has to be done by this nation and this country to meet the crisis now on our hands. It goes without saying that every man in this room, from a sense of patriotism, from his love of his country, is going to do everything in his power to help out the situation.

We engineers are going to give the best that there is in us. Mr. Lockett has outlined very wisely and with a great deal of thought what we might do. Major Moore has stated that, after all, the man on the front has to be a soldier. He has to know what to do with the things that are given to him to fight with. Sir Douglas Haig has said that for every man on the firing line it took five men to equip him and to keep him furnished with supplies, munitions, quartermasters, commissary department, things which are needed for him to fight successfully.

We are about to raise an army of one million men. It will become necessary, then, to select various kinds of men. It will be necessary to see that men do not go on the firing line when they are better equipped to remain behind the firing line and do the work of these five men who are necessary to prepare and furnish the fighting man with what is necessary to accomplish or win his fight. I am told that in England, at the beginning of this war, thousands and tens of thousands of men volunteered and went to the firing line, and then it was found that they were better fitted, better suited, to be at home, preparing munitions and supplies and supplying the army with that which was needed to fight. I think I see a little daylight through the various talks which we have had before us this evening. The only dark spot, and that is very dark, indeed, is time. It takes time to do things, to accomplish things.

The work of selection and making a census of the industries which would be useful and necessary in the conduct of war has been very ably performed, in this case, by Mr. Lockett and his committee. The Government at Washington has a very complete record of the plants and factories that can be converted into the manufacture of that equipment which is necessary to an army. Something, however, is very necessary in addition to this, and I think Major Moore has touched upon it. Mr. Lockett has also touched upon it. We want a census of men who can do things, and we want to know what they can do. We want to know the name, the address, the age, the capacity of every civil engineer, of every mechanical engineer, of every chemist, of every mechanic, of every electrician. We want that so that when the call comes the right men will find their right places and their proper places without the necessity of first sending them to the wrong place and then bringing them back to do the work for which they are best fitted.

I think that the societies of engineers, both mechanical and civil, should, by the nature of their profession, come in touch with technical men of all kinds, that our Society could easily, under the direction of a committee, of its president, resolve itself into committees, not only in the city, but throughout the State, and make a census. It is quite possible that the Government has already issued instructions for this. If the Government has issued instructions, we can place ourselves subject to the officers of the United States Army or of the Government, to work in that direction. In that way we can be immediately useful. Upon our shoulders, or upon the shoulders, perhaps, of the older men of our profession, will devolve the duty of finding, of equipping, of directing the efforts of these five other men who are necessary to supply the one man on the firing line. The duty of organization of the work behind the firing line is going to be an immense undertaking, and the training of engineers, the training which we have received in our profession, I believe, renders us especially fitted to perform this work, under the direction, of course, of the military heads, who must command and direct everything.

PROFESSOR C. S. WILLIAMSON. I realize perfectly well that men must be had, and that trained men must be had, officers must be had, patrols must be maintained on our coasts, patrols must be maintained on land at certain points, but back of all of that is the serious side, that we must furnish the material which has been spoken of here tonight, with which these men who patrol may actually carry out the patrol. Now, we have a survey which has been spoken of also, that was made by the Naval Consulting Board, through its various State organizations, in which 144 of us have participated in this State, and we have that on file in Washington, as a fairly complete survey; but even with that there is yet a serious consideration that some of those materials in that survey are not inexhaustible in the United States. It may become necessary for us as engineers to be called into service in the actual manufacturing of certain supplies very much more intensively than we have spoken of tonight.

I don't think this is the time to lay bare any actual facts and figures, but there are some commodities which we do not produce in the United States which are absolutely essential to either land or naval warfare. There are certain commodities which are at hand and can be readily put into use. I know one plant in this state that has a certain by-product that goes into the sewers, that with a very small equipment could be turned into one of the essentials for making cordite. I know one other concern here that could turn another by-product to a useful purpose which is not listed in our survey—and was not so stated. These are by-products which have not been actually thought of as being turned into use.

Now, the point I want to bring out is this: there are certain manufacturing plants that could be turned to immediate use if it became necessary. We have not a sugarhouse in the State of Louisiana that could not be turned to the manufacture of materials to be used in making explosives. We have one certain product that could be made in our sugarhouses here. We have a second product which could be made in the sugarhouse which is absolutely essential to the manufacture of explosives. We have here in Louisiana a natural resource for the manufacture of explosives which has not been exploited, which I believe could be put up and operated on fairly short notice, a certain product which could be manufactured here.

TENTATIVE DRAFT OF A CODE OF SAFETY STANDARDS FOR POWER-TRANSMISSION MACHINERY[1]

Rules and Requirements for the Protection of Industrial Workers from Hazards Commonly Presented by Mechanical Equipment Used for Transmitting and Distributing Power from the Prime Movers to the Various Power-Utilizing Machines, Tools and Devices

NOTE—The use of properly designed, constructed and installed individual motor-driven equipment with electrical power distribution not only eliminates many of the hazards demanding this Code, but also gives an uninterrupted distribution of natural and artificial light, and a greater flexibility and range of speeds than is possible with mechanical power-distributing systems.

The following specifications describe standard guards for all power-transmission equipment hereinafter mentioned, and apply to all main shafting, jack shafting, drive shafting and countershafting, and their belts and other attachments up to but not including belts actually driving machines.[2]

2 *Class A Guards:* If the clearance between the guard and the guarded part is less than five (5) inches, a metal guarding material that will not admit objects larger than one-half (½) inch in diameter, strong enough to withstand loads to which it may be subjected, durable enough to withstand ordinary wear and tear, substantially fabricated and erected, and free from sharp points and edges.

3 *Class B Guards:* If the clearance between the guard and the guarded part is five (5) inches or more, a metal guarding material that will not admit objects larger than two (2) inches in diameter, strong enough to withstand loads to which it may be subjected, durable enough to withstand ordinary wear and tear, substantially fabricated and erected, and free from sharp points and edges.

4 *Handrails:* If the clearance between the guard and the guarded part is fifteen (15) inches or more (measured horizontally from extreme parts within six (6) feet of floor), a handrail forty-two (42) inches in height with at least one intermediate rail, supported at least every eight (8) feet, substantially fabricated and erected, with no sharp points or edges.

5 If constructed of pipe, the rails and posts shall be at least equal in strength to one and one-fourth (1¼)-inch standard-weight pipe.

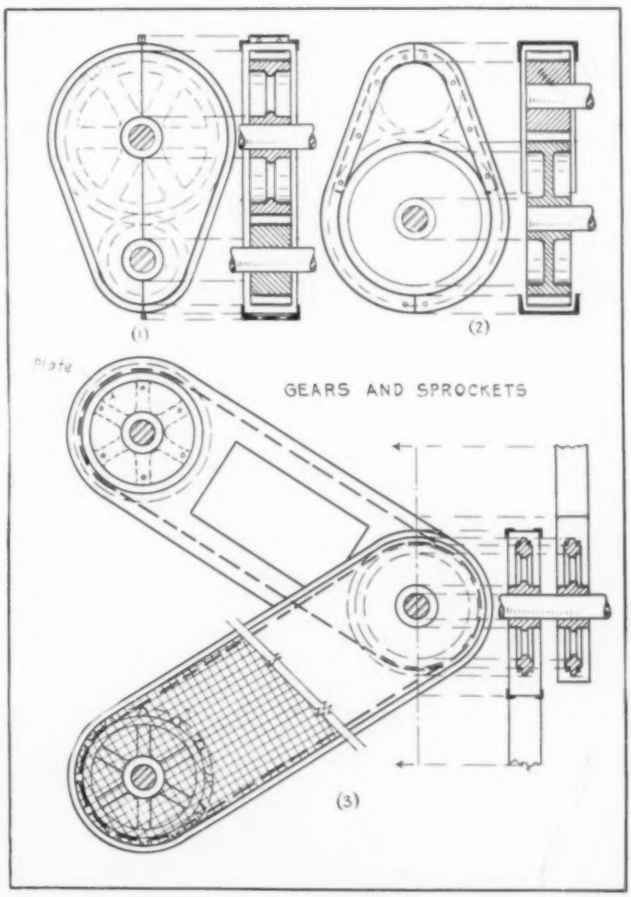
6 If constructed of structural metal, the rails and posts shall be at least equal in strength to two by two by one-fourth (2 x 2 x ¼)-inch angles.

7 If constructed of wood, the top rail shall be two inches by four inches (2 x 4), the center rail one inch by four inches (1 x 4), and the posts four inches by four inches (4 x 4), all straight-grained lumber dressed on four sides, or other construction of equal strength.

8 *Toe Boards.* When power-transmission equipment extends through floors or into pits, Class A and B guards shall extend to the floors, or toe boards six (6) inches in height shall be provided around the floor opening in addition to standard handrails. (See Figs. 6, 7, 11, 14, 30, 31, 34, 48.)

9 *Sanitary Bases.* Class A and B guards, for power-transmission equipment not extending through floors, shall enclose exposed sides to two (2) inches below the bottom of the lowest moving part when the clearance between that part and the floor is less than eight (8) inches; or when the clearance between the lowest moving part and the floor is eight (8) inches or more, the guards shall be closed on the bottom, or extended on all sides down to six (6) inches above the floor. (See Figs. 15, 26, 36-40, 42, 43, 49-54.)

10 *Gears and Sprockets.* All power-driven gears and sprockets shall be completely enclosed on exposed sides with



FIGS. 1 TO 3 GUARDS FOR GEARS AND SPROCKETS

standard guards as specified in Class A or B, except in cases where the design and operation of the parts to be guarded make a complete enclosure clearly impractical; in which case the face of the gears or sprockets shall be covered with a band guard surrounding all exposed teeth, with flanges on both sides extending inward beyond the roots of the teeth, and there shall be a continuous smooth web cast or fitted between the hubs and rims of the gears or sprockets. (See Figs. 1, 2, 3.)

11 *Vertical and Inclined Belts, Ropes, Chains.* All vertical and inclined belts, ropes and chains used for transmitting or

[1] Compiled and presented by Carl M. Hansen and Rufus W. Hicks, under the direction and with the approval of the Committee on Health and Safety, National Association of Manufacturers. Submitted by the Sub-Committee on the Protection of Industrial Workers for the consideration of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[2] Belts actually driving machines will be considered "machine belts," and therefore a subject for machine codes.

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distributing power (except belts traveling less than 120 feet per minute, or transmitting so little power that accidental contact therewith could cause no accident) shall be provided with standard guards as specified in Class A or B, six (6) feet high on exposed sides, or on exposed sides and top, or with a standard handrail on exposed sides. (See Figs. 4 to 46, inclusive.)

12 *Horizontal Belts, Ropes, Chains.* All horizontal belts, ropes and chains used for transmitting or distributing power (except belts traveling less than 120 feet per minute, or transmitting so little power that accidental contact therewith could cause no accident) shall be guarded as follows:

13 *Low Belts.* If the upper part of the belt is lower than six (6) feet above the floor or working platform, it shall be provided with standard guards specified in Class A or B, six (6) feet high on exposed sides, or on exposed sides and top, or with a standard handrail on exposed sides. (See Figs. 47-50.)

14 *Medium Belts.* If the upper part of the belt is higher than six (6) feet above the floor or working platform and the lower part of the belt is lower than six (6) feet above the floor or working platform, it shall be provided with standard guards as specified in Class A or B, six (6) feet high on exposed sides, or with a standard handrail on exposed sides. (See Figs. 51-58.)

15 *High Belts.* If the lower part of the belt is higher than six (6) feet above the floor or working platform and lower than seven (7) feet above the floor, it shall be provided with standard guards as specified in Class A or B, on exposed sides and bottom, or with standard handrail on exposed sides. (See Figs. 59, 60.)

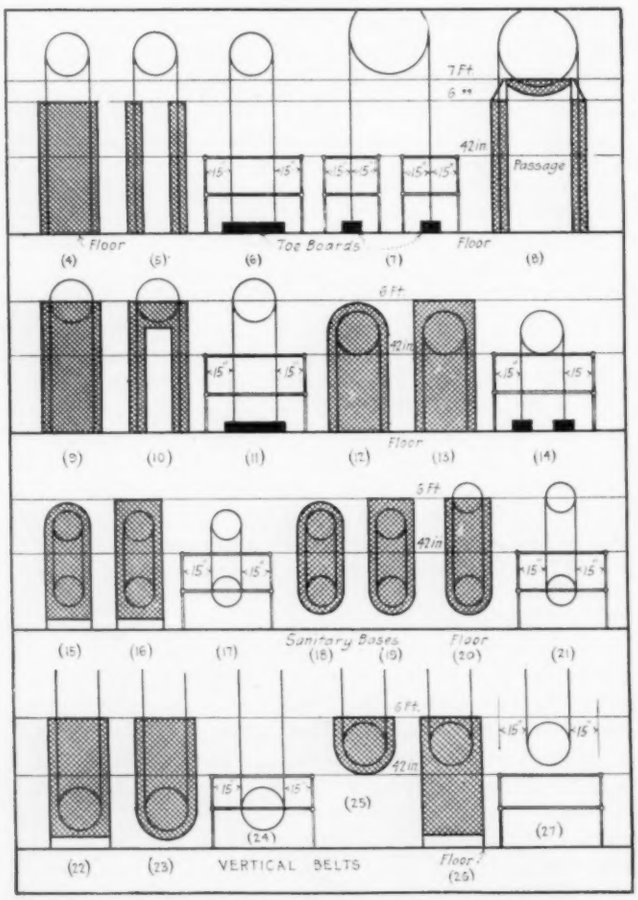
16 *Belts over Driveways.* Where a horizontal belt is located over a driveway or passageway, the highest floor of any wagon or truck passing beneath the belt shall be considered a working platform.

17 *Belt Fasteners.* All belts not provided with guards as specified in Class A or B and within seven (7) feet of the floor or working platform shall be free from metal lacings and metal fasteners.

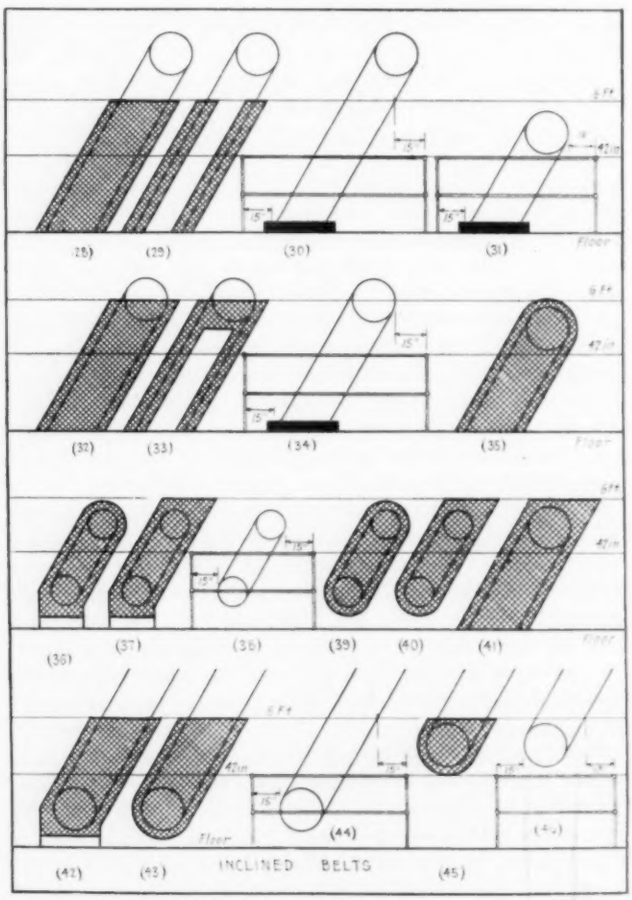
18 *Belt Shifters.* Belt shifters shall be provided for all tight- and loose-pulley belts, and shall be so designed and constructed that ordinary vibrations or accidental contact will not alter the set position, and shall have a controlling handle conveniently located. (See Figs. 61-63.)

19 *Pulleys.* Pulleys belted from above or from the side in such a way as to allow passage beneath the pulley, and within seven (7) feet of the floor or working platform and not completely enclosed by standard belt guards or handrails, shall be guarded to the top of the pulley or to a height of seven (7) feet above the floor or working platform on exposed sides and beneath by guards as specified in Class A or B, or be enclosed on exposed sides by standard handrails. (See Figs. 64-67.)

20 *Bearing Clearance.* The clearance on shafting between pulleys and bearings or between pulleys and fixed objects shall be not less than thirty-six (36) inches and wider than the belt, or the pulleys shall be guarded on the near side with stationary guards as specified in Class A or B, and all revolving ob-



FIGS. 4 TO 27 GUARDS FOR VERTICAL BELTS



FIGS. 28 TO 46 GUARDS FOR INCLINED BELTS

jects in the clearance shall be smooth, cylindrical and concentric with shafting. (See Figs. 68-73.)

21 *Belt Clearance.* The clearance on shafting between pulleys and pulleys, collars, couplings or other revolving attachments shall be wider than the widest belt used, or the pulleys shall have flanges or guards to prevent the belt from dropping into the clearance. (See Figs. 68-73.)

22 *Abandoned Pulleys.* Pulleys without belts shall be guarded as though belted, or removed from revolving shafts.

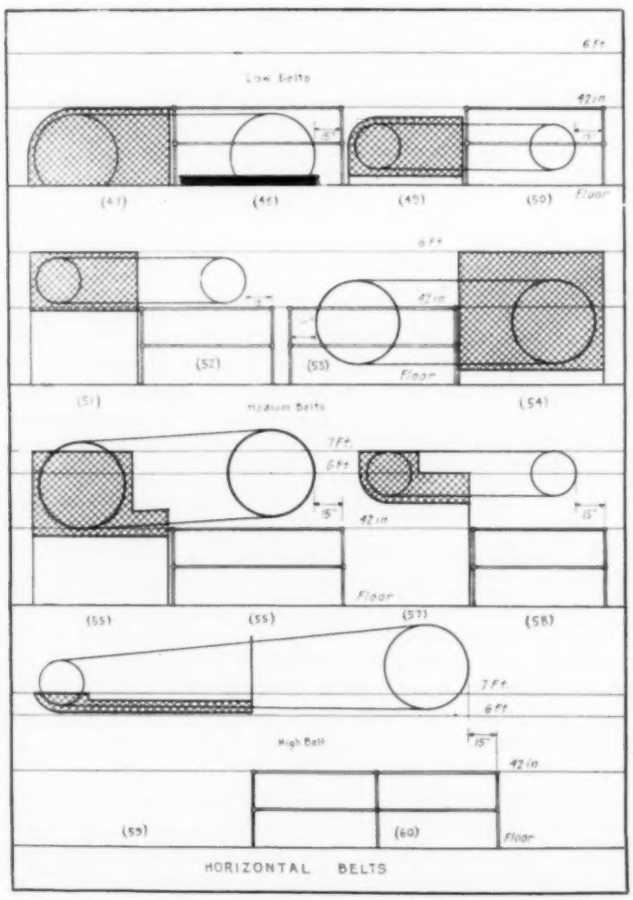
23 *Clutches.* Friction clutches, jaw clutches and compression clutches within seven (7) feet of the floor or working platform or within thirty-six (36) inches of a bearing shall

27 *Clamp Couplings.* Clamp couplings and makeshift devices of irregular shape or unknown strength are prohibited on power-driven shafting.

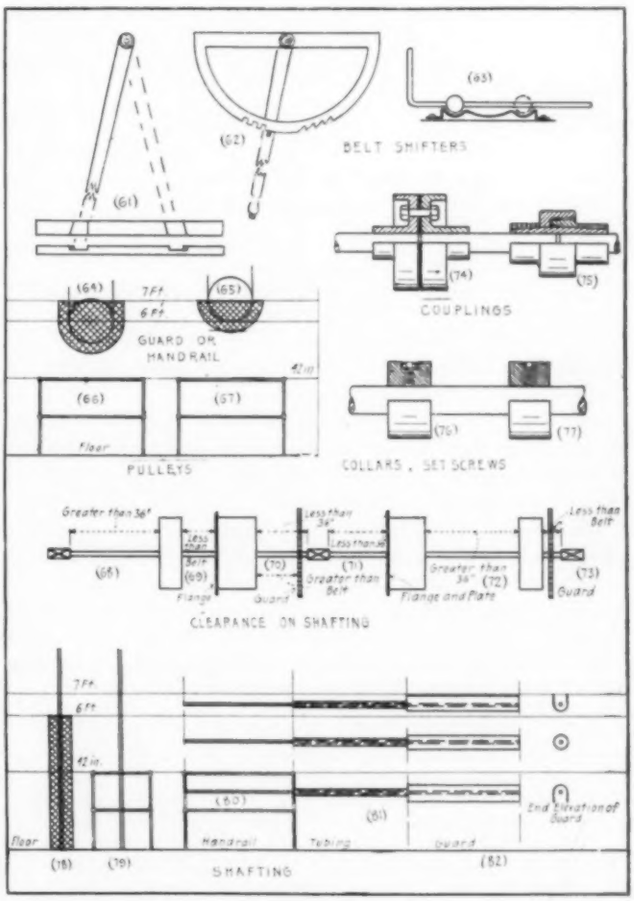
28 *Collars.* Assembled collars shall be smooth, cylindrical and concentric with shafting, with no projecting parts or attachments. (See Figs. 76, 77.)

29 *Set Screws.* All set screws in revolving parts not enclosed by standard guards as specified in Class A or B shall be flush with or countersunk below the periphery of the part retaining the set screws. (See Figs. 76, 77.)

30 *Keys.* All keys or keyways in revolving shafting not enclosed by standard guards as specified in Class A or B shall



FIGS. 47 TO 60 GUARDS FOR HORIZONTAL BELTS



FIGS. 61 TO 82 GUARDS FOR MISCELLANEOUS EQUIPMENT

have their operating mechanism completely enclosed in stationary guards as specified in Class A or B, or in smooth, concentric revolving guards of solid construction with no projecting parts or attachments.

24 *Couplings.* All couplings within seven (7) feet of the floor or working platform or within thirty-six (36) inches of a bearing shall be guarded as follows:

25 *Rigid Couplings.* Sleeve couplings and flange couplings shall be cylindrical and concentric with the shafting and with no parts or attachments projecting beyond the largest periphery of the coupling or its projecting flanges. (See Figs. 74, 75.)

26 *Flexible Couplings.* Flexible and universal couplings shall be completely enclosed in standard stationary guards as specified in Class A or B, or in smooth concentric revolving guards of solid construction.

be made flush with the end and periphery of the shaft or enclosed by smooth, cylindrical concentric guards.

31 *Vertical Shafting.* Vertical shafting with or without collars, couplings, clutches, pulleys, or other attachments shall be enclosed on exposed sides with standard guards as specified in Class A or B to a height of six (6) feet above the floor or working platform, or with a standard handrail. (See Figs. 78, 79.)

32 *Horizontal Shafting.* Horizontal shafting with or without collars, couplings, clutches, pulleys, or other attachments, including dead ends, within seven (7) feet of the floor or working platform, shall be enclosed on all exposed sides with standard guards as specified in Class A or B or with standard handrail, or with freely revolving tubing. (See Figs. 80-82.)

33 *Shafting over Driveways.* Where horizontal shafting is

located over driveways or passageways, the highest floor of a wagon or truck passing beneath the shafting shall be considered a working platform.

34 *Emergency Stop Stations.* A station or stations shall be provided in each room, section, or department to stop immediately all power-transmission equipment therein. Such station or stations shall be properly marked and easily accessible and provided with means for locking in "stop" position.

35 *Bearings.* Where possible, bearings shall be of a self-oiling type with reservoir capacities for at least 24 hours' running or shall have other methods of oiling which do not bring the oiler in the danger zone, and shall have necessary drip cups and pans securely fastened in position.

36 *Lubrication.* Oiling which brings the oiler in a danger zone shall be done only by an authorized person, and while the machinery is not in motion.

37 *Oiler's Clothes.* The oiler must not wear loose or flowing clothing.

38 *Oiler's Lock.* The oiler shall be provided with a lock and key or with a key to the locks at the emergency stop stations, and with a warning sign to display at the stations when at work on machinery controlled by that station. He shall be required to lock the station in a "stop" position and display the sign before going to work, and unlock and remove the sign when the work is completed and all men have left dangerous places.

39 *Starting Signals.* Ample notice should be given by means of an effective alarm or signal in all departments before power-transmission equipment is started.

40 *Inspection.* All power-transmission equipment should be carefully inspected at frequent and regular intervals by foremen or authorized inspectors, and defective equipment should be reported for repair and records kept of inspections.

41 *Repairs and Adjustments.* Repairs and adjustments to power-transmission equipment or guards therefor shall be made only when the power is cut off from that equipment, and guards shall be replaced in protective position before the power is cut on.

42 *Removing Guards.* Guards installed in accordance with this Code shall not be removed or rendered ineffective.

Respectfully submitted,

JOHN PRICE JACKSON, *Chairman*
JOHN H. BARR
MELVILLE W. MIX
M. W. ALEXANDER
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JOHN W. UPP
WILLIAM A. VIALL
CARL M. HANSEN

SUB-COMMITTEE ON THE PROTECTION OF INDUSTRIAL WORKERS

CORROSION RESEARCH LABORATORY IN ENGLAND

A new corrosion research laboratory has been equipped from a grant from the Department of Scientific and Industrial Research in England at Brighton, and the Royal School of Mines, with the purpose of prosecuting further the investigation begun by Capt. G. B. Bengough and Dr. O. F. Hudson under the auspices of the Corrosion Research Committee.

From explanations given by Capt. Bengough to some technical journalists it appears that at the present time the work is being concentrated on the causes of corrosion in condenser tubes. Copper-zinc tubes are being subjected to investigation chiefly with the view of determining the causes that lead to dezincification, which is the beginning of many corrosive troubles. Ordinary 70:30 tubes were exhibited which showed dezincification arising from spills in the wall, the presence of oxide in the metal annealing at wrong temperatures, improper pitching, and the presence of swarf holes. Capt. Bengough also showed a sample made from an alloy which was prepared in such a way that an oxide-free tube was drawn from it, another which was 90 per cent copper and 10 per cent nickel, and a third of 92.5 per cent copper and 7.5 per cent aluminum. These special tubes were under experimental tests and were kept under close observation and extremely valuable information was expected from the investigation. It was known that 98:2 copper-nickel was unsuitable for condenser work; likewise an 80.20 alloy, since they failed in the laboratory to attack a 90:10 tube and intended to transfer that experiment shortly to Brighton.

Among other things which, according to *Page's Engineering Weekly* of April 20, 1917, were shown by Capt. Bengough to the technical journalists, was an optical instrument designed for determining the position of every discernible surface flow in each tube that is put into the experimental condenser; also an annealing furnace and the sea-water tanks in which the preliminary corrosion tests are made.

NEW MALLEABLE CASTINGS METHOD

According to the *Iron Age*, April 19, 1917, a new method of making malleable-iron castings, doing away with the air furnace, will be used in the plant now being built by the National Malleable Castings Company, Cleveland. The metal will be melted in a cupola and a portion of the melted charge, depending on the amount of carbon and other impurities to be removed (usually about one-fifth of the total), will then be run into a side-blow bessemer converter, in which the carbon, manganese and silicon will be partially or wholly blown out. The treated metal is then to be combined in a ladle with the remainder of the metal from the cupola, and the charge transferred to an electric furnace in which the refinement of the metal will be completed. If such complete refinement is not required the metal may be cast without being subjected to the final refinement in the electric furnace. The melting equipment will consist of four 72-in. Whiting cupolas, bessemer converters built by the company, and four 6-ton Heroult electric furnaces.

The method of pouring will also be a radical departure from the usual practice. Instead of pouring directly into small ladles, the metal will be poured from the electric furnaces into ladles of 12,000 to 14,000 lb. capacity and carried a considerable distance with traveling cranes and then poured into small ladles. From the latter the metal will be poured into the molds. This practice will necessitate the installation of a greater number of cranes than would otherwise be required. Twelve or fourteen traveling cranes, up to 20 tons capacity, will be provided. The plant is expected to be ready for operation about January 1, 1918.

The seventh Edison Medal, awarded to Nikola Tesla for meritorious achievements in his early original work in polyphase and high-frequency electric currents, was presented to him at the annual meeting of the American Institute of Electrical Engineers in the Auditorium of the Engineering Societies Building, New York, on the evening of May 18. President H. W. Buck presided and addresses were made by Dr. A. E. Kennelly, Chairman of the Edison Medal committee, Charles A. Terry, and B. A. Behrend, Mem.Am.Soc.M.E.

REVISION OF BOILER CODE

THE COUNCIL of the Society has directed that the proposed changes in the Boiler Code be published in The Journal with the request that any desired discussion on the proposed changes be mailed to the Boiler Code Committee for consideration. These proposed changes embody suggestions made at the meetings held at the Society headquarters December 8 and 9, 1916, at which all those interested were invited to attend and participate in the discussions.

At the last meeting of the Boiler Code Committee it was decided to publish all revisions so far agreed on by the Committee. There are other revisions which will be published later on, with the request that they also be discussed. This will make it possible for any one to discuss the proposed revisions before they are brought to the final form and presented to the Council of the Society for approval.

NOTE. *Only such portions of the Code as are subject to revision are here presented, with references to their proper paragraph numbers.*

PAGE 8

PAR. 12. CHANGE PAR. 12 TO READ AS FOLLOWS:

12 Cast iron shall not be used for nozzles or flanges attached directly to the boiler at any pressure or temperature. Cast iron shall not be used for boiler and superheater mountings such as connecting pipes, fittings, valves and their bonnets, for steam temperatures of over 450 deg. fahr.

PAR. 13. CHANGE PAR. 13 TO READ AS FOLLOWS:

13 Water-leg and door-frame rings of vertical fire-tube boilers, and of locomotive and other type boilers, shall be of wrought iron or steel, or cast steel of Class A or Class B grade, as designated in the Specifications for Steel Castings. The OG or other flanged construction may be used as a substitute in any case.

PAGE 9

PAR. 19. CHANGE PAR. 19 TO READ AS FOLLOWS:

19 The minimum thickness of butt straps shall be given as in Table 1. Intermediate values shall be determined by interpolation. For plate thicknesses exceeding 1¼ in., the thickness of the butt straps shall be not less than three-quarters of the thickness of the plate.

PAGE 11

PAR. 25. MAKE THE FOLLOWING CHANGES IN PAR. 25:

Strike out the word "Copper" in the table, and under "Firebox" strike out "not over 0.05 per cent."

PAGE 31

PAR. 123. MAKE THE FOLLOWING CHANGE IN PAR. 123*a*:

Change the percentage of yield point from 0.6 tensile strength to 0.5.

PAGE 34

PAR. 141. MAKE THE FOLLOWING CHANGE IN PAR. 141:

Change the percentage of yield point from 0.6 tensile strength to read 0.5 tens. str.

PAGE 40

PAR. 164. MAKE THE FOLLOWING CHANGE IN PAR. 164:

In Par. 164 after the word "knobbled" insert a comma.

PAR. 167. CHANGE PAR. 167 TO READ AS FOLLOWS:

167 *Flange Test.* *a* For tubes not more than 6 in. diameter a test specimen not less than 4 in. in length shall have a flange turned over at right angles to the body of the tube without showing cracks or flaws. This flange as measured from the outside of the tube shall have a width of from ⅛ in. to ½ in. The width between these limits to be not less than 10 per cent of the outside diameter of the tube. For tubes more than 6 in. diameter the flange test is not required.

b In making the flange test, the flaring tool and die block as shown in Fig. 7, may be used.

PAGE 41

PAR. 169. CHANGE PAR. 169 TO READ AS FOLLOWS:

169 *Hydrostatic Tests.* Tubes under 5 in. in diameter shall stand an internal hydrostatic pressure of 1000 lb. per sq. in. and tubes 5 in. in diameter or over, an internal hydrostatic pressure of 800 lb. per sq. in., provided that the fibre stress does not exceed 16,000 lb. per sq. in. in which case the test pressure shall be determined by the following formula

$$P = \frac{32{,}000}{D} \times t$$

where t is the wall thickness in inches; D is the inside diameter in inches. Lapwelded tubes shall be struck near both ends, while under the test pressure, with a 2 lb. steel hand hammer, the blow to be equivalent to 2 lb. falling 2 ft.

PAGE 42

PAR. 174. CHANGE PAR. 174 TO READ AS FOLLOWS:

174 *Workmanship.* Finished tubes 3½ in. or under in outside diameter shall be circular within 0.02 in. and the mean outside diameter shall not vary more than 0.015 in. from the size ordered. For tubes over 3½ in. in outside diameter, these variations shall not exceed 0.5 per cent of the outside diameter. All tubes shall be carefully gaged with a B.W.G. gage and shall not be less than the gage specified. Tubes on which the standard slot gage, specified, will go on tightly at the thinnest point, will be accepted. The length shall not be less, but may be 0 125 in. more than that ordered.

PAGE 44

PAR. 184. CHANGE PAR. 184 TO READ AS FOLLOWS:

184 *Circumferential Joints.* *a* The strength of circumferential joints of boilers, the heads of which are not stayed by tubes or through braces, shall be at least 50 per cent of that required for the longitudinal joints of the same structure.

b When 50 per cent or more of the load which would act on an unstayed solid head of the same diameter as the shell, is relieved by the effect of tubes or through stays in consequence of the reduction of the area acted on by the pressure and the holding power of the tubes and stays, the strength of the circumferential joints in the shell shall be at least 35 per cent of that required for the longitudinal joints.

c In circumferential joints of horizontal return tubular boilers the shearing strength of the rivets shall be not less than 50 per cent of the full strength of the plate corresponding to the thickness at the joint.

PAGE 45

PAR. 186. CHANGE PAR. 186 TO READ AS FOLLOWS:

186 *Welded Joints.* The ultimate strength of a joint which has been properly welded by the forging process, shall be taken as 28,500 lb. per sq. in., with steel plates having a range in tensile strength of 47,000 to 55,000 lb. per sq. in. Autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the requirements of the Code and where the safety of the structure is not dependent upon the strength of the weld. Autogenous welding shall not be used in place of caulking or girth joints.

PAR. 187. CHANGE PAR. 187 TO READ AS FOLLOWS:

187 *Riveted Longitudinal Joints.* The riveted longitudinal joints of a shell or drum which exceeds 36 in. in diameter, shall be of butt and double-strap construction. This rule does not apply to the portion of a boiler shell which is staybolted to the firebox sheet.

PAR. 190. CHANGE PAR. 190 TO READ AS FOLLOWS:

190 In horizontal return tubular boilers with lap joints no course shall be over 12 ft. long. With butt and double strap construction longitudinal joints of any length may be used provided the tension test specimens are so cut from the plate that their lengthwise direction is parallel with circumferential seams of the boiler and the tests meet the standards prescribed in the specifications for boiler plate steel.

PAR. 194. CHANGE THE FIRST SECTION OF PAR. 194 TO READ AS FOLLOWS:

194 *Domes.* The longitudinal joint of a dome 24 in. or over in diameter shall be of butt and double-strap construction irrespective of pressure. When the maximum allowable working pressure exceeds 100 lb. per sq. in. the flange of a dome 24 in. or over in diameter shall be double riveted to the boiler shell.

PAGE 49

PAR. 195. ADD AFTER NOTATION FOLLOWING FORMULA IN PAR. 195:

Where two radii are used the longer shall be taken as the value of L in the formula.

ADD AT THE END OF PAR. 195:

When a dished head has a manhole opening, the thickness as found by these Rules shall be increased by not less than $\frac{1}{8}$ in. over that called for by the formula.

PAGE 50

PAR. 199. ADD THE FOLLOWING TO THE LIST OF VALUES OF C IN PAR. 199:

$C = 150$ for stays screwed through plates or made a taper fit and having the heads formed on the stays before installing them and not riveted over, said heads being made to have a true bearing on the plate and the diameter of the heads being not less than 1.4 times the diameter of the stays.

REVISE MATTER FOLLOWING LIST OF VALUES OF C TO MAKE IT READ AS FOLLOWS:

If flat boiler plates not less than $\frac{3}{8}$ in. thick are strengthened with doubling plates securely riveted thereto and having a thickness of not less than 2/3 t, then the value of t in the formula shall be three-quarters of the combined thickness of the boiler plate and doubling plates but not more than one and one-half times the thickness of the boiler plate, and the values of C given above may also be increased 15 per cent.

When two sheets are connected by stays and but one of these sheets requires staying, the value of C is governed by the thickness of the sheet requiring staying.

PAR. 200. CHANGE PAR. 200 TO READ AS FOLLOWS:

200 *Staybolts.* The ends of screwed staybolts shall be riveted over or upset by equivalent process. Staybolts must be hollow or the outside ends of solid staybolts shall be drilled with a hole at least 3/16 in. diameter to a depth extending at least $\frac{1}{2}$ in. beyond the pressure side of the plates, except on boilers having a grate area not exceeding 15 sq. ft., or the equivalent in gas or oil fired boilers, where the drilling of the staybolts is optional. Flexible staybolts of either the jointed or ball and socket type need not be drilled.

PAR. 201. ADD TO PAR. 201 THE FOLLOWING:

If the outstanding legs of the two members are fastened together so that they may act as one member in resisting the bending action produced by the load on the rivets attaching the members to the head of the boiler, and provided that the spacing of these rivets attaching the members to the head is approximately uniform, the members may be figured as a single beam uniformly loaded and supported at the points where the through braces are attached.

PAGE 51

PAR. 203. CHANGE PAR. 203 TO READ AS FOLLOWS:

203*a* The maximum spacing between centers of rivets or between the edges of tube holes and the centers of rivets attaching the crowfeet of braces to the braced surface, shall be determined by the formula in Par. 199, using 135 for the value of C.

b The maximum distance between the edges of tube holes and the centers of other types of stays shall be determined by the formula in Par. 199 using the value of C given in Par. 199 which applies to the thickness of plate and type of stay used.

c The maximum spacing between the inner surface of the shell and lines parallel to the surface of the shell passing through the centers of the rivets attaching the crowfeet of braces to the head shall be determined by the formula in Par. 199, using 175 for the value of C.

d The maximum distance between the inner surface of the shell and the centers of braces of other types shall be determined by the formula in Par. 199 using a value of C equal to 1.3 times that value of C in Par. 199 which applies to the thickness of plate and type of stay as therein specified.

e In applying these rules and those in Par. 199 to a head or plate having a manhole or reinforced opening, the spacing applies only to the plate around the opening and not across the opening.

UNDER TABLE 3 INSERT:

For the application of Pars. 205, 206 and 207, see Appendix (Par. . . .) (illustrations in Case No. 13).

PAGE 53

PAR. 214. CHANGE PAR. 214 TO READ AS FOLLOWS:

214 *Areas of Segments of Heads to be Stayed.* The area of a segment of a head to be stayed shall be the area enclosed by lines drawn 2 in. from the tubes and a distance d from the shell as shown in Figs. 13 and 14. The value of d shall be the larger of the following values but not less than 3 in.

(Note:—Dimensions marked 3″ in Figs. 13 and 14 to be changed to d.)

(1) d = the outer radius of the flange not exceeding eight times the thickness of the head

(2) $$d = \frac{5 \times t}{\sqrt{P}}$$

Where

d = distance in inches
t = thickness of head in sixteenths of an inch
P = maximum allowable working pressure in lb. per sq. in.

PAR. 215. CHANGE PAR. 215 TO READ AS FOLLOWS:

215 When drum heads of water tube boilers are 30 in. or less in diameter and the tube plate is stiffened by flanged ribs or gussets, no stays need be used if a hydrostatic test to destruction of a boiler or unit section built

in accordance with the construction, shows that the factor of safety is at least 5.

PAR. 216. CHANGE PAR. 216 TO MAKE IT READ AS FOLLOWS:

216 Stays shall be used in the tube sheets of a fire tube boiler if the distance between the edges of the tube holes exceeds the maximum pitch of staybolts for the corresponding plate thickness and pressure given in Table 3. That part of the tube sheet which comes between the tubes and the shell need not be stayed if the nearest tangent common to two tube holes when measured on any radius of the tube sheet that intersects the tangent between the holes does not exceed this maximum pitch by more than 3 in. The tube holes to which a common tangent may be drawn in applying this rule shall not be at a greater distance from edge to edge than the maximum pitch referred to.

PAGE 54

PAR. 218. ADD THE FOLLOWING TO PAR. 218:

The distance in the clear between the bodies of the braces, or of the inside braces where more than two are used, shall not be less than 10 in. at any point.

PAR. 220. CHANGE PAR. 220 TO READ AS FOLLOWS:

220*a* The full pitch dimensions of the stays shall be employed in determining the area to be supported by a stay and the area occupied by the stay shall be deducted therefrom to obtain the net area. The product of the net area in square inches by the maximum allowable working pressure in lb. per sq. in. gives the load to be supported by the stay.

b Where stays come near bounding surfaces and special allowances are made for the spacing, the load to be carried by such stays shall be determined by neglecting the added area provided for by these special allowances. For example, if the minimum pitch by Table 3 would make a staybolt come 6 in. from the edge of the plate and a special allowance would make it come 7 in., the distance of 6 in. should be used in computing the load to be carried.

c The maximum allowable stress per square inch net cross sectional area of stays and staybolts shall be as given in Table 4.

d The length of the stay between supports shall be measured from the inner faces of the stayed plates. The stresses are based on tension only. For computing stresses in diagonal stays, see Pars. 221 and 222.

TABLE 4. ADD LINE AFTER ITEM *b* IN TABLE TO READ AS FOLLOWS:

c Steel through stays exceeding 1½ in. diameter	10,400	9000

CHANGE PRESENT ITEM *c* IN TABLE TO ITEM *d*.

PAGE 55

PAR. 223. CHANGE PAR. 223 TO READ AS FOLLOWS:

223 *Diameter of Pins and Area of Rivets in Brace.* All rivet and pin holes shall conform with the requirements in Par. 253 and the pins shall be made a neat fit. To determine the sizes that shall be used proceed as follows:

1. Determine the "required cross-sectional area of the brace" by first computing the total load to be carried by the brace, and dividing the total load by the values of stresses for unwelded stays given in Table 4.

2. Design the body of the brace so that the cross-sectional area shall be at least equal to the "required cross-sectional area of the brace" for unwelded braces. Where the braces are welded, the cross-sectional area at the weld shall be at least as great as that computed for a stress of 6000 lb. per sq. in. (see Table 4).

3. Make the area of pins to resist double shear at least three-quarters of the "required cross-sectional area of the brace."

4. Make the combined cross-section of the eye at the side of the pin (in crowfoot braces) of at least 25 per cent greater than the "required cross-sectional area of the brace."

5. Make the combined cross-sectional area of the rivets at each end of the brace at least one and one-quarter times the "required cross-sectional area of the brace."

6. Design each branch of a crowfoot to carry two-thirds the total load on the brace.

7. Make the net sectional areas through the sides of the crowfoot, tee irons, or similar fastenings at the rivet holes at least equal to the required rivet section, that is, at least equal to one and one-quarter times the "required cross-sectional area of the brace."

8. Make the cross-sectional areas through the blades of diagonal braces where attached to the shell of the boiler at least equal to the required rivet section, that is, at least equal to one and one-quarter times the "required cross-sectional area of the brace."

PAGE 58

PAR. 231. CHANGE PAR. 231 TO READ AS FOLLOWS:

231 *Maximum Allowable Working Pressure on Truncated Cones.* *a.* Upper combustion chambers of vertical submerged tubular boilers made in the shape of a frustum of a cone when not over 38 in. diameter at the large end, may be used without stays if figured by the rule for plain cylindrical furnaces (Par. 239) making D in the formula equal to the diameter at the large end.

b When over 38 in. in diameter at the large end, that portion which is over 30 in. in diameter shall be fully supported by staybolts or gussets to conform to the provisions for staying flat surfaces. In this case the top row of staybolts shall be at a point where the cone top is 30 in. or less in diameter.

In calculating the pressure permissible on the unstayed portion of the cone, the vertical distance between the horizontal planes passing through the centers of the rivets at the cone top, and through the center of the top row of staybolts shall be used as L in Par. 239, and D in that paragraph shall be the inside diameter at the center of the top row of staybolts.

PAGE 61

PAR. 239. CHANGE FIRST PARAGRAPH OF PAR. 239 TO READ AS FOLLOWS:

239 *Plain Circular Furnaces.* Unstayed furnaces *more than* 18 *in. diameter* when riveted or of seamless construction or such furnaces when lapwelded by the forging process shall have walls not less than 5/16 in. thick. The maximum allowable working pressure for such furnaces shall be determined by one or the other of the following formulæ:

MAKE DEFINITION OF L READ AS FOLLOWS:

L = total length of furnace between centers of head rivet seams (not length of a section), in.

INSERT AFTER THE FORMULA AND JUST PRECEDING THE EXAMPLE IN PAR. 239, ELIMINATING THE PRESENT SENTENCE:

Where the furnace has a riveted longitudinal joint, it may be of the lap type for inside diameters not exceeding 30 in. but shall be of butt and strap construction for inside diameters exceeding 30 in. The efficiency of the joint shall be greater than:—

$$\frac{P \times D}{1250 \times T}$$

PAGE 64

PAR. 246. CHANGE PAR. 246 TO PAR. 246*a*

PAR. 247. CHANGE PAR. 247 TO PAR. 246*b*

CHANGE PAR. 247 TO READ AS FOLLOWS:

247 Where it is impossible to calculate with a reasonable degree of safety the strength of a boiler structure or any part thereof, a full sized sample shall be built by the manufacturer and tested to destruction in the presence

of the Boiler Code Committee or a representative of the Boiler Code Committee appointed to witness such test.

PAR. 250. CHANGE PAR. 250 TO READ AS FOLLOWS:

250 A fire-tube boiler shall have the ends of the tubes substantially rolled and beaded, or rolled and welded, at the firebox or combustion chamber end.

PAGE 65a

PAR. 253. CHANGE PAR. 253 TO READ AS FOLLOWS:

253 *Riveting.* Rivet holes shall be drilled full size or they may be punched not to exceed ¼ in. less than full diameter for material over 5/16 in. in thickness, and ⅛ in. less than full diameter for material not exceeding 5/16 in. in thickness, and then drilled or reamed to full diameter.

PAR. 255. ADD TO PAR. 255 THE FOLLOWING:

Forms of rivet heads that will be acceptable are shown in Fig 17*a*.

PAGE 65b

PAR. 257. CHANGE PAR. 257 TO READ AS FOLLOWS:

257 *Calking.* The calking edges of plates, butt straps and heads shall be beveled. Every portion of the sheared surfaces of the calking edges of plates, butt straps and heads shall be planed, milled or chipped to a depth of not less than ⅛ in. Calking shall be done with a round-nosed tool.

PAGE 67

PAR. 266. CHANGE PAR. 266 TO READ AS FOLLOWS:

266 A vertical fire-tube boiler, except boilers of steam fire-engines, or boilers 24 in. or less in diameter shall have not less than seven handholes, located as follows: Three in the shell at or about the line of the crown sheet; one in the shell at or about the water-line or opposite the fusible plug when used; three in the shell at the lower part of the waterleg. A vertical firetube boiler, submerged tube type, shall have two or more handholes in the shell, in line with the upper tube sheet. All boilers 24 in. or less in diameter, shall have at least one opening for inspection and one opening in addition to the blow-off, for washing out the boiler, these openings to be fitted with brass plugs.

PAGE 68

PAR. 268. CHANGE PAR. 268 TO READ AS FOLLOWS:

268 *Threaded Openings.* An opening in a boiler for a threaded pipe connection 1 in. in diameter or over shall have not less than the number of threads given in Table 7.

INSERT TABLE HERE

If the thickness of the material in the boiler is not sufficient to give such number of threads, there shall be a pressed steel flange, bronze composition flange, steel-cast flange or steel plate, so as to give the required number of threads.

PAR. 269. CHANGE PAR. 269 TO READ AS FOLLOWS:

269 *Safety Valve Requirements.* Each boiler shall have two or more safety valves, except a boiler for which one safety valve 2 in. size or smaller is required by these Rules; in which case one or more may be used.

PAGE 69

PAR. 273. CHANGE PAR. 273 TO READ AS FOLLOWS:

273 Each safety valve shall be plainly marked by the maufacturer. The markings may be stamped on the body, cast on the body or stamped or cast on a plate or plates riveted to the body and shall contain the following:

a. The name or identifying trademark of the manufacturer

b. The nominal diameter with the words "Bevel Seat" or "Flat Seat"

c. The steam pressure at which it is set to blow

d. The lift in inches of the valve disc from its seat, measured at a pressure 3 per cent higher than that at which the valve is set to blow

e. The weight of steam discharged in pounds per hour at a pressure 3 per cent higher than that for which valve is set to blow

PAGES 70-71-72

TABLE 8. TABLE 8 TO BE OMITTED.

PAGE 73

PAR. 275*a*. CHANGE PAR. 275*a* TO READ AS FOLLOWS:

275 Safety valve capacity may be checked in any one of three different ways, and if found sufficient, additional capacity need not be provided:

a. By making an accumulation test, that is, by shutting off all other steam discharge outlets from the boiler and forcing the fires to the maximum. The safety valve equipment shall be sufficient to prevent an excess pressure beyond that specified in Par. 270.

PAR. 279. ADD TO PAR. 279 THE FOLLOWING:

279 Where discharge pipes are used ample drainage shall be provided at or near the safety valve.

PAGE 74

PAR. 282. CHANGE PAR. 282 TO READ AS FOLLOWS:

282 For purposes of inspection and to insure the valve being free, each safety valve used on a boiler shall have a substantial lifting device by which the valves may be raised by an amount equal to one-twentieth of the nominal diameter of the valve up to the maximum limit of 1/16 in. when there is no pressure on the boiler.

PAR. 283. ADD TO PAR. 283 THE FOLLOWING:

The seats and discs of safety valves shall be non-ferrous material. The seat of a safety valve shall be fastened to the body of the valve in such a way that there is no possibility for the seat to lift.

ADD TO PAR. 284 THE FOLLOWING:

Springs used in safety valves shall not show a permanent set exceeding 1/32 in. ten minutes after being released from a cold compression test closing the spring solid. And the spring shall be so constructed that the valve can lift from its seat one-tenth the diameter of the seat before the coils are closed or before there is other interference.

PAR. 286. CHANGE PAR. 286 TO READ AS FOLLOWS:

286 All dimensions shall conform to the American Standard given in Tables 15 and 16 of the Appendix for the pressure therein specified, except that the face of the safety valve flange and the nozzle to which it is attached shall be flat and without the raised face for pressures up to and including 250 lb. per sq. in. For higher pressure, the raised face shall be used.

PAGE 75

PAR. 291. ADD TO PAR. 291 THE FOLLOWING:

The lowest permissible water level for various classes of boilers is given in Par. 430 of the Appendix.

PAR. 292. CHANGE PAR. 292 TO READ AS FOLLOWS:

292 No water glass connection shall be fitted with an automatic shut-off valve, except when the automatic shut-off valves are so constructed that the two connections to the water glass can be blown through separately and the steam connection cannot be entirely closed thereby.

PAR. 296. ADD TO PAR. 296 THE FOLLOWING:

Where the use of a long pipe becomes necessary a shut-off valve or cock arranged so that it can be locked or

sealed open may be used near the boiler. Such a pipe shall be of ample size and arranged so that it may be cleared by blowing out.

PAGE 76

PAR. 299. CHANGE PAR. 299 TO READ AS FOLLOWS:

299 *Nozzles and Fittings.* Flanged cast iron pipe fittings used for boiler parts, for pressures up to and including 160 lb. per sq. in. shall conform to the American Standard given in Tables 15 and 16 of the Appendix, except that the face of the flange of a safety valve as well as that of a safety valve nozzle, shall be flat and without the raised face. For pressures above 160 lb. per sq. in., steel cast and wrought steel fittings shall be used for boiler parts with exceptions specified in Pars. 9 and 12. An allowable variation of 20 per cent from the flange thickness required by Tables 15 and 16 may be made for steel cast and forged steel fittings, leaving the drilling of bolt holes unchanged. For pressures above 250 lb. per sq. in., the flange thickness and the thickness of the bodies shall be increased to keep within the same deflection limits and to give at least the same factor of safety as the fittings specified in Tables 15 and 16. The face of the flange of a safety valve, as well as that of a safety valve nozzle, shall have a flat face for pressures up to and including 250 lb. per sq. in. and shall have raised face at higher pressures. Tables 15 and 16 do not apply to flanges on the boiler side of steam nozzles or to flanges left by the manufacturer as part of the boiler, and do not apply to fittings designed as part of the boiler.

PAR. 307. CHANGE PAR. 307 TO READ AS FOLLOWS:

307 *Blow-Off Piping.* A surface blow-off pipe shall not exceed 1½ in. pipe size and shall form a continuous passage with the blow-off pipe external to the boiler. The internal and external pipes shall be separate with clearance between their ends and arranged so that the removal of either will not disturb the other. A brass or steel bushing as shown in Fig. 19, or flanged connection shall be used.

PAGE 77

PAR. 311. CHANGE PAR. 311 TO READ AS FOLLOWS:

311*a*. When the maximum allowable working pressure exceeds 125 lb. per sq. in., on all boilers except those used for traction and portable purposes, each bottom blow-off pipe shall have two valves, or a valve and a cock, and such valves, or valve and cock, shall be extra heavy, except that on a boiler having multiple blow-off pipes, a single master valve may be placed on the common blow-off pipe from the boiler, in which case only one valve on each individual blow-off is required.

b. On all traction and portable boilers when the maximum allowable working pressure exceeds 125 lb. per sq. in., each bottom blow-off pipe shall have one extra heavy valve.

PAR. 315. MAKE THE LAST SENTENCE OF PAR. 315 READ AS FOLLOWS:

The feed pipe shall be carried through the head or shell near the front end in the way specified for a surface blow-off in Par. 307 and be securely fastened inside the shell above the tubes.

PAGE 79

PAR. 325. CHANGE PAR. 325 TO READ AS FOLLOWS:

325 Lugs or brackets, when used to support boilers of all types shall be properly fitted to the surfaces to which they are attached. The shearing and crushing stresses on the rivets used for attaching the lugs or brackets shall not exceed 8 per cent of the strength given in Pars. 15 and 16.

PAR. 328. CHANGE PAR. 328 TO READ AS FOLLOWS:

328 A water tube boiler which is fired by hand shall have the firing door or doors of the inward opening type unless such doors are provided with substantial and effective latching devices to prevent them from being blown open by pressure on the furnace side.

PAGE 80

FIG. 20. CHANGE FIG. 20, PAR. 332, TO READ AS FOLLOWS:

(Name of State)
.....STD
Year put into service.
Safe Working Pressure.
(Name of Builder)
.....

PAGE 81

PAR. 339. CHANGE PAR. 339 TO READ AS FOLLOWS:

339 A boiler to be used exclusively for low pressure steam heating may be constructed either of cast iron, steel cast, or wrought iron or steel or any combination of these, but in all cases the connecting rods and bolts shall be wrought iron or steel.

PAGE 82

PAR. 343. CHANGE PAR. 343 TO READ AS FOLLOWS:

343 In a *hot-water* boiler to be used exclusively for heating buildings or hot water supply, when the diameter does not exceed 60 in. and the grate area does not exceed 10 sq. ft., or equivalent, as defined in Pars. 359 and 360, longitudinal lap joints will be allowed.

When the grate area exceeds 10 sq. ft., or equivalent, as defined in Par. 360, and the diameter of the boiler does not exceed 60 in. longitudinal lap joints will be allowed, providing the maximum allowable working pressure does not exceed 50 lb. per sq. in.

PAGE 84

TABLE 9. TITLE OF TABLE 9 TO BE CHANGED TO READ AS FOLLOWS:

Allowable Sizes of Safety Valves for Steam Heating Boilers, of Water Relief Valves for Water Heating Boilers, and of Hot Water Supply Boilers.

PAGE 85

PARS. 359 AND 360. INSERT THE FOLLOWING CENTER HEAD:

GRATE AREA

PAR. 359. CHANGE PAR. 359 TO READ AS FOLLOWS:

359 *Double Grate Down Draft Boilers.* In boilers of this type the grate area shall be taken as one and one-quarter times the area of the lower grate.

PAR. 361. CHANGE PAR. 361 TO READ AS FOLLOWS:

361 *Steam Gages.* Each *steam* boiler shall have a steam gage connected to the steam space or to the water column or its steam connection, by means of a syphon or equivalent device of sufficient capacity to keep the gage tube filled with water and so arranged that the gage cannot be shut off from the boiler except by a cock placed near the gage and provided with a tee or lever handle arranged to be parallel with the pipe in which it is located when the cock is open. Connections to gages shall be of brass, copper or bronze composition. The dial of a steam gage for a *steam* heating boiler shall be graduated to not less than 30 lb.

PAGE 86

PAR. 365. CHANGE PAR. 365 TO READ AS FOLLOWS:

365 *Damper Regulators.* When a pressure damper regulator is used, it shall be connected to the steam space of the boiler.

PAGE 87

PAR. 373. CHANGE PAR. 373 TO READ AS FOLLOWS:

373. *Hot-water* boilers for a maximum allowable working pressure not exceeding 30 lb. per sq. in. used exclusively for heating buildings or for hot-water supply, when constructed of cast iron, steel cast, or wrought iron or plate steel or any combination of these, shall be subjected to a shop test of 60 lb. per sq. in. hydrostatic pressure applied to the boiler or the section thereof.

PAR. 374. CHANGE PAR. 374 TO READ AS FOLLOWS:

374 A maximum allowable working pressure in excess of 30 lb. per sq. in. will be allowed on a hot-water boiler constructed of cast iron, steel cast, or wrought iron or plate steel or any combination of these, used exclusively for heating buildings or for hot-water supply, provided such boilers or their sections have been subjected to a shop hydrostatic test of two and one-half times the actual working pressure.

PAR. 377. CHANGE PAR. 377 TO READ AS FOLLOWS:

377 *Name.* All boilers referred to in this section shall be plainly and permanently marked with the manufacturer's name and the maximum allowable working pressure.

All heating boilers built according to these rules may be marked A.S.M.E. standard.

PAGE 91

PAR. 391*a*. CHANGE PAR. 391*a* TO READ AS FOLLOWS:

391 Safety valve capacity may be checked in any one of three different ways, and if found sufficient, additional capacity need not be provided;

a By making an accumulation test, that is, by shutting off all other steam discharge outlets from the boiler and forcing the fires to the maximum. The safety valve equipment shall be sufficient to prevent an excess pressure beyond that specified in Par. 270.

PAGE 93

PAR. 402. CHANGE PAR. 402 TO READ AS FOLLOWS:

402 When the maximum allowable working pressure exceeds 125 lb. per sq. in., the blow-off pipe shall be extra heavy from boiler to valve or valves, and shall run full size without reducers or bushings. All fittings between the boiler and valve shall be steel or extra heavy fittings of bronze, brass, malleable iron or cast-iron.

PAGE 107

PAR. 421. CHANGE PAR. 421 TO READ AS FOLLOWS:

421 *Method of Computing Discharge Capacity.* The required discharge capacity of a safety valve or valves for a boiler may be based either on the heat units in the fuel consumed or on the amount of steam generated.

The number of heat units that each safety valve will handle, for valves of the ordinary types in which the discharge capacity is proportioned to the lift, may be obtained as follows:

$U = 161{,}000 \times P \times D \times L$ for Bevel Seats at 45 deg.
$U = 227{,}500 \times P \times D \times L$ for Flat Seats

The amount of steam that a valve will discharge may be found as follows:

$W = 110 \times P \times D \times L$ for Bevel Seats at 45 deg.
$W = 155 \times P \times D \times L$ for Flat Seats

Where

U = Number of heat units per hour that a safety valve will handle, B.t.u.
W = Quantity of steam that a safety valve will handle per hour, lb.
P = Absolute boiler pressure or gage pressure plus 14.7 lb. per sq. in.
D = Inside diameter of valve seat, in.
L = Vertical lift of valve disc, measured with 3 per cent excess pressure, in.

PAR. 422. CHANGE PAR. 422 TO READ AS FOLLOWS:

422 The maximum quantity of fuel C that can be burned per hour at the time of maximum forcing is determined by a test. The maximum number of heat units per hour, or $C \times H$ is then determined, using the values of H given in Par. 427. The weight of steam generated per hour is found by the formula:

$$W = \frac{C \times H \times 0.75}{1{,}100}$$

The sum of the safety valve capacities marked on the valves shall be equal to or greater than W.

PAGE 108

PAR. 423. REPLACE MATTER AFTER STATEMENT OF EXAMPLE BY:

$C \times H = 2150 \times 12{,}100 = 26{,}015{,}000$
$W = C \times H \times 0.75 \div 1100 = 17{,}740$

A $3\frac{1}{2}$ in. bevel seated valve with 0.11 in. lift would discharge in heat units

$U = 161{,}000 \times 239.7 \times 3\frac{1}{2} \times 0.11$
$= 14{,}858{,}000$

and in weight of steam

$W = 110 \times 239.7 \times 3\frac{1}{2} \times 0.11$
$= 10{,}150$

From which it can be seen that either method indicates that two such valves will give the proper relieving capacity.

PAR. 424. REPLACE MATTER AFTER STATEMENT OF EXAMPLE BY:

$C \times H = 2000 \times 6400 = 12{,}800{,}000$
$W = C \times H \times 0.75 \div 1100 = 8730$

A bevel seated $3\frac{1}{2}$ in. valve is marked by the manufacturer 0.11 in. lift and discharge capacity for 100 lb. pressure = 4840 lb.; hence two such valves would be required.

PAR. 425. REPLACE MATTER AFTER STATEMENT OF EXAMPLE BY:

$C \times H = 1000 \times 18{,}500 = 18{,}500{,}000$
$W = C \times H \times 0.75 \div 1100 = 12{,}620$

A bevel seated $2\frac{1}{2}$ in. valve is marked by the manufacturer 0.08 in. lift and discharge capacity for 275 lb. pressure = 6350 lb.; hence two such valves would be required.

PAR. 426. REPLACE MATTER AFTER STATEMENT OF EXAMPLE BY:

$C \times H = 3000 \times 960 = 2{,}880{,}000$
$W = C \times H \times 0.75 \div 1100 = 1960$

A bevel seated 2 in. valve is marked by the manufacturer 0.07 in. lift and discharge capacity for 150 lb. pressure = 2500 lb.; hence one such valve would be required.

PAGE 109

PAR. 427. CHANGE PAR. 427 TO MAKE FIRST SENTENCE READ AS FOLLOWS:

For the purpose of checking the safety valve capacity as described in Par. 422, the following values of heats of combustion of various fuels may be used.

ALSO CHANGE HEADINGS IN TABLES WHICH FOLLOW TO MAKE THEM READ:

H = B.t.u. per lb.

and

H = B.t.u. per cu. ft.

PAGES 113-114

PAR. 430. MAKE FIRST LINE OF PAR. 430 TO READ AS FOLLOWS:

430 Each boiler may have one or more fusible plugs located at the lowest permissible water level as follows:

ADD AT THE BOTTOM OF P. 114 (PAR. 430):

v Fire Engine Boilers are not usually supplied with fusible plugs. Unless special provision is made to keep the water above the firebox crown sheet other than by the natural water level, the lowest permissible water level shall be at least 3 in. above the top of the firebox crown sheet.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

THE SPRING MEETING AT CINCINNATI

THE largest audience at any Spring Meeting of the Society was present at the joint meeting with the Machine Tool Builders' Association on Tuesday afternoon, May 22. The meeting was addressed by Dean Herman Schneider, of the University of Cincinnati, on The Trend in Engineering Training, and by Dr. Otto P. Geier, social physician of the Cincinnati Milling Machine Company, on The Human Potential in Industry.

Dean Schneider outlined various educational plans for bringing the student in contact with practical work in the industries and with the workmen. He illustrated with lantern slides the work of his own students of the University of Cincinnati, under the well-known coöperative plan which he has so successfully carried out with Cincinnati firms for regular employment in the shops during the college course.

Dr. Geier's address was an inspiration in showing the important service which the social physician can render in maintaining the health of the workers and removing physical causes leading to lack of interest or loss of time; and by developing intimate relations in a way to be genuinely helpful to the employees.

The two addresses were delivered to indicate the attention which industrial Cincinnati is giving to the human side of industrial problems. The visitors were urged to remain longer in the city in order to study these methods at first hand.

The meeting concluded with some excellent and unusual moving pictures of the manufacture of 9.2 shells, arranged for and contributed by the publishers of *Machinery*.

Notes

Council Meeting. The Council directed the issuing of a questionnaire to the membership, to provide for the enlisting of members in the public service in the present emergency, and also for the future needs of the Society.

Business Meeting. Amendments to the Constitution proposed by the Constitution and By-Laws Committee were announced. It was stated by the President that the Council, as expressing the obvious desire of the whole membership, had voted to invest in Liberty Bonds part of the money necessarily needed in the running of the Society, even at some possible inconvenience.

General Session. President Hollis, Vice-President Benjamin and Manager Toltz presided alternately. At the close, Mr. Toltz spoke of his recent trip to Honolulu and his reception by the A.S.M.E. members there and the Hawaiian Engineering Association. He brought the greetings of the latter to the Society. Attendance about 220.

Registration. Indications are, at time of going to press, that the registration will exceed that at any previous Spring convention. The total number of members registered at end of the second day was 370, and the total of guests 490. Attendance at previous largest Spring Meetings: Chicago (1904), 350; Pittsburgh (1911), 305.

At the Machine Shop Session there were 200 in attendance throughout, many standing in the room.

An enthusiastic conference of delegates from local Sections was held, at which each man from each city recited briefly the experiences of his organization for the year and outlined plans of future work. Sections Committee Chairman Yarnall described plans of the Sections Committee to make the Sections the strongest factor in the Society work. Both President Hollis and Secretary Rice told the delegates frankly that their first aim should be service to their communities. The delegates accorded a rising vote of thanks of the Sections to the Cincinnati Local Committee for the splendid arrangements for the Spring Meeting.

The University of Cincinnati Student Branch held an enthusiastic meeting at the University on Tuesday evening. About 75 were present. Secretary Rice opened the meeting. President Hollis, Mr. William Kent, Mr. Carl G. Barth, and Mr. L. P. Alford gave good talks to the men. These were followed by an entertainment and smoker, arranged for and carried out by the students.

THE SECRETARY'S MONTHLY LETTER

THE coöperation of the Society with the Government, as was outlined in last month's Journal, is developing still more intimately. Calls from the departments directly and by firms responding to Government emergency orders are frequent.

As an outgrowth of the activity of members of our Society in their relation as citizens of Fairfield County, Connecticut, in the Fairfield County Resource Mobilization Committee, a meeting of The American Society of Mechanical Engineers from not only Bridgeport but all of the surrounding towns was held this month, attended by the members of the Sections Committee with the result, as elsewhere reported in this issue, that an Organization Committee has been appointed with representatives from each of the big centers in Connecticut, to draw up a plan whereby the whole State of Connecticut will be provided with section meetings. With this as a precedent, it is hoped to extend the Society organization through many other similarly thickly populated districts so that the benefits of membership will be still further extended.

As is stated in another place, and of such importance that it should be repeated here, the National Academy of Sciences has just elected four engineers, which, so far as I am informed, is the first time that an engineer as such has been elected to the highest body of men of science of any country.

Neither are physicians, as such, elected, the reason always having been because of the sharp distinction drawn between pure and applied science. The two members of our Society who were elected are Prof. W. F. Durand and Dr. S. W. Stratton; the member of the Mining Engineers was Dr. Henry M. Howe, and of the Electrical Engineers, Mr. J. J. Carty. It has been indicated previously—and particularly in the last number of THE JOURNAL—that the engineering societies are closely coöperating through the Engineering Foundation with the National Research Council appointed by the President of the National Academy of Sciences. This coöperation is destined to be very close, and in fact the resources of the entire Society will sooner or later be called on by the Research Council.

The sole ambition of the Society is to render the greatest possible service to the Government, under all circumstances.

As an outcome of the extraordinary activity of the Government in munition manufacture, several pieces of standardization work, which are now especially urgent, will undoubtedly be started or revived, and the coöperation of the members of the Society is specially urged for the sake of the country. Obviously, inconvenience and perhaps some actual loss of stocks will follow the processes of standardization, but with the proper attitude on the part of all, these losses can be minimized and the greatest good secured.

The Secretary also wishes to ask the assistance and the cooperation of the membership in the Industrial Census supplementing that taken last year but undertaken now under the auspices of the states. The members are requested to kindly notify the Secretary of all such requests so that the machinery of the Society can always be availed of to the fullest extent.

CALVIN W. RICE,
Secretary.

Council Notes[1]

THE following members were present at the meeting of the Council on April 20: Ira N. Hollis, *President,* John H. Barr, C. E. Benjamin, R. H. Fernald, W. F. M. Goss, A. M. Greene, Jr., F. R. Hutton, W. B. Jackson, D. S. Jacobus, C. T. Main, C. T. Plunkett, John A. Stevens, and Calvin W. Rice, *Secretary.* Louis C. Marburg, member of the Sections Committee, and F. R. Low, chairman of the Publication Committee, were also present by invitation.

In view of the present national emergency, it was voted that authority be given to the President to nominate, subject to confirmation of the Council, such additional committees and representatives as may be requested from time to time by either the Council of National Defense or the National Research Council.

Council of National Defense. In response to an invitation from the Advisory Commission of the Council of National Defense, it was voted that the President and Secretary be nominated to represent this Society on the Commission's Committee on Science and Research, including Engineering and Education.

Engineering Committee of National Research Council. In response to the invitation of the National Research Council, W. F. Durand and Charles D. Young were nominated to represent this Society on the Engineering Committee of the Council. The Secretary announced that John R. Freeman had been elected a member-at-large on the National Research Council.

[1] The May JOURNAL went to press before the April meeting.

Advisory Committee on Gunmounts. The Council acknowledged and accepted as a command from the Secretary of War, the appointment of President Hollis and Past-President Jacobus to act on a special advisory committee on gunmounts.

Conserving Engineering Resources. Dr. Jacobus spoke of the desirability of placing on record an opinion that for the best interests of the country effort should be made to conserve the engineering talent as represented in the colleges of the country, both in graduate and undergraduate bodies, and to prevent if possible too hasty enlistment in the regular army and naval militia service. It was voted that Dr. Hollis Godfrey be invited to address a letter to the various colleges, informing them of the best use to which students and graduates can be put at this time, and advising that these men be conserved for the special fields in which their training would be especially useful and adaptable.

Engineer Officers' Reserve Corps. The name of the Joint Committee on Engineer Officers' Reserve Corps was changed to Committee on National Defense, the committee to cooperate with similar committees of the other societies. The committee has recently addressed instructions to the members of the Society who contemplate enlistment in the Army or Navy.

Military Engineering Committee. In response to the request of the chairman, and uniform with the action of the other three national engineering societies, the members of this Society now serving on the Military Engineering Committee of New York were authorized and appointed to represent the Society. These members are: Messrs. Gano Dunn, Alexander C. Humphreys, D. S. Jacobus, John W. Lieb, Ralph D. Mershon, Calvin W. Rice, W. L. Saunders, Bradley Stoughton, and W. H. Wiley.

National Academy of Sciences. The Secretary announced that Prof. W. F. Durand had been elected a member of the Academy.

U. S. Bureau of Mines. In response to a request from the Bureau of Mines for the appointment of a special Advisory Committee to the Bureau, and two sub-committees on Fuel and Mine Equipment, the Research Committee was appointed as the Special Advisory Committee.

Engineering Council. Amendments to the By-Laws of The United Engineering Society, creating The Engineering Council, "to consider means for more intimate relations between engineers for discussion of questions of general interest and for united action," were approved.

Constitution and By-Laws. Important changes in the Constitution and By-Laws of the Society were proposed by the Committee on Constitution and By-Laws and will be presented at the Council meeting to be held at Cincinnati on May 21, in connection with the Spring Meeting.

Membership Committee. The Secretary reported difficulty and embarrassment on the part of the Membership Committee to meet regularly, on account of the extraordinary pressure of personal business and national affairs, and it was voted that a statement be made in THE JOURNAL that on account of present conditions the matter of election to membership must necessarily proceed more slowly than usual.

A.S.M.E. Boiler Code. Interpretations in cases Nos. 136 to 145 were approved and ordered published in THE JOURNAL. They were included in the May issue.

Sections. The formation of a Section in Toronto, Canada, to include all members residing within a radius of sixty miles but not outside the Province of Ontario, and in the following cities in Ontario: Ashburnham, Collingwood, Cobourg, Oril-

lia, Palmerston, Port Dover, Peterborough, and Waterford, was approved.

Oscar Elsas, chairman, Cecil P. Poole, secretary, Earl F. Scott, Robert Gregg, and J. N. G. Nesbit were approved as the Executive Committee of the Atlanta Section, to continue in office until July 1, 1918.

P. N. Engel was appointed secretary of the Chicago Section, to succeed R. E. Thayer.

George I. Rockwood, chairman, R. G. Williams, secretary, V. P. Edwards, H. P. Fairfield, and F. W. Parks were appointed as the Executive Committee of the Worcester Section, to take office July 1, 1917.

Spring Meeting, 1918. It was voted to accept the invitation of the City of Worcester, Mass., to hold the Spring Meeting, 1918, in that city.

Graphics Committee. H. E. Crampton, representing the American Genetic Association, and Henry H. Norris, representing the Society for the Promotion of Engineering Education, were appointed as members of the Joint Committee on Standards for Graphic Presentation.

CALVIN W. RICE,
Secretary.

Past-Presidents in Hawaii

We have now received an account of the visit of Past-Presidents Brashear, Swasey, and Freeman to Hawaii, in connection with their tour of the Orient. The party was entertained by the Hawaiian Engineering Association at a number of affairs. They were met by a committee from the association, consisting of Messrs. W. G. Hall, Mem.Am.Soc.M.E., Carl B. Andrews, R. R. Hind, Mem.Am.Soc.M.E., S. T. Carr, B. F. Howland, J. M. Young, Mem.Am.Soc.M.E., and E. Köpke, Mem.Am.Soc.M.E.

Their stay at the Island is best described in the following letter from Mr. Swasey, just received:

MY DEAR MR. RICE:

Our excursion to the Hawaiian Islands was especially interesting, made doubly so by Messrs. B. F. Howland and E. Köpke, who were delegated by the Hawaiian Engineering Society to accompany us.

We first stopped at the Island of Maui, and there visited the Crater of Haleakala (House of the Sun), the largest extinct volcano in the world. The crater is about 7½ miles long; 2½ miles wide, and ½ mile deep. We went by automobile to the Half-way House, about 5,000 ft. in elevation, and Mr. Brashear remained there all night. The rest of us took ponies and went on to the summit. We were fortunate in having a beautiful view, and we remained over night, returning to the Half-way House about noon the next day, and then on down to the sea level.

We also visited one of the most up-to-date sugar refineries on the island, and were given every opportunity to see the most advanced methods and processes for extracting sugar from the cane.

That night we went by boat to Hilo, on the Island of Hawaii, where a special train was awaiting us for a trip along the coast, through interesting sugar plantations, a distance of about 35 miles. Returning to Hilo, we took autos and went to the volcano of Kilauea, about 30 miles distant, and about 4,000 ft. high, which is one of the most wonderful sights of the world. The crater is about 1,200 ft. in diameter, and the lake of fire is about 125 ft. from the top. When I was there about six years ago, it was about 450 ft. from the top. We remained at the Volcano House over night, and thus had a chance to see the crater by night. It is even more wonderful then than by day.

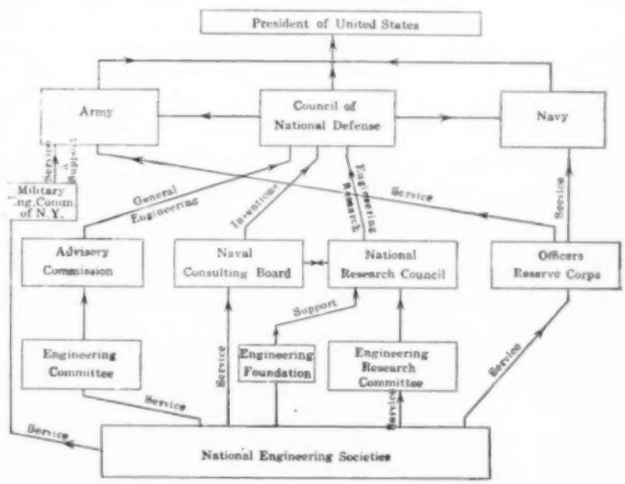
The next morning we returned to Hilo, and then took the boat for Honolulu, arriving there Saturday morning. The whole trip, extending from Monday afternoon until Saturday morning, was extremely interesting, and gave us an opportunity to see something of the wonderful productive possibilities of those rich islands. The ten days we spent in Honolulu and in visiting the various islands were among the most pleasant of our entire trip, and I shall ever have happy memories of the good friends who did so much for us while we were there.

Very truly yours,
(Signed) AMBROSE SWASEY.

To add to the distinction of having our three past-presidents at the islands, Mr. Max Toltz, member of the Council of the Society, was also at Honolulu, and he too was the guest of the local engineering association.

Engineers and the Government

Last month we published an account of the agencies through which the membership of the national engineering societies is in contact with the Government in the present emergency. We reproduce herewith a chart which visualizes the relationship of these agencies.



CONNECTIONS BETWEEN THE GOVERNMENT AND THE ENGINEERS

The Military Engineering Committee of New York, shown on the left of the diagram as connecting the societies directly with the Army, is the outcome of the military engineering lectures organized in New York City some twelve months ago in the interest of Preparedness. The committee is organizing a regiment of engineers in the metropolis to be sent to France as soon as equipped.

The members of our Society on this committee are Messrs. Gano Dunn, Alex C. Humphreys, D. S. Jacobus, John W. Lieb, Ralph D. Mershon, Calvin W. Rice, W. L. Saunders, Bradley Stoughton, and W. H. Wiley.

There has also just been organized by President Hollis a Committee of our Society on Military Personnel. This committee will procure and classify information regarding the qualifications of the members, particularly with reference to their ability to serve the country.

Engineers Elected to Academy

The National Academy of Sciences has conferred a distinct honor upon the engineering profession by electing to its membership four engineers: Prof. W. F. Durand, Mem.Am.Soc.M.E., Dr. S. W. Stratton, Mem.Soc.M.E., Dr. Henry M. Howe and Mr. J. J. Carty. The Academy has also conferred upon Dr. Stratton the Public Welfare Medal.

The Academy is not so well known, perhaps, among engineers, but the significance of these elections may be judged from the facts that new members are chosen from the most distinguished men of the United States, and that the Academy is analogous to the Royal Society of London.

The Academy was incorporated in 1863 for the purpose of examining and investigating any subject of science or art and for making reports of special investigations at the call of the United States Government. It has about 150 members and 45 foreign associates, and a number of standing committees, including mathematics, physics and engineering, and weights, measures and coinage.

A new president of the academy has just been elected, Dr. Charles D. Walcott, secretary of the Smithsonian Institution, who succeeds Prof. William H. Welch. Dr. A. A. Michelson has been elected to the vice-presidency to fill the vacancy caused by this election.

The Academy is now in contact with the Government through the National Research Council which was recently appointed at the request of President Wilson. An account of the formation and work of the council was given in the last issue of THE JOURNAL.

Presentation of the John Fritz Medal

The John Fritz Medal, awarded to Dr. Henry Marion Howe, in January of this year, for "his investigations in metallurgy, especially in the metallography of iron and steel," was presented to him in the Auditorium of the Engineering Societies Building, New York, on the evening of Thursday, May 10. A full account of the ceremonies will appear in the July issue of THE JOURNAL.

Patriotic Dinner at Providence

The second annual dinner of the Providence Engineering Society, affiliated with the Am.Soc.M.E., held on the evening of May 2, was characterized as an expression of "rampant patriotism." At the head tables were representatives of Belgium, Canada, France and the United States. Each speaker received his full meed of praise, but it fell to the lot of Capt. M. de Jarny, a French military officer sent to this country after 18 months' service in the trenches to instruct the Harvard training camp, to receive round after round of applause. A few minutes later, Capt. Nathan Horowitz, representing the United States Army, received almost as enthusiastic a reception. Prof. Albert Van Hecke, of the University of Louvain, spoke for Belgium and showed motion pictures of efficiency methods adopted in the refugee camps in Holland, and which had been worked out by himself.

On the stage, behind the speakers' table, was a representation of a bivouac, with stacked rifles, shelter tents, packs and other military equipment. Also in evidence was a new projection machine, given to the society by John R. Freeman, Mem.Am.Soc.M.E.

Mayor Gainer was the first speaker, after R. W. Adams, the vice-president of the society, had presented Col. H. Anthony Dyer as toastmaster. The Mayor welcomed the distinguished guests of the evening.

Captain de Jarny followed, saying in part:

"The United States, the greatest engineering country in the world, is sure to play a great part in the war because it is an engineers' war. Here in Rhode Island, engineering has been developed to a greater extent than in any other part of the country, for it is here that are built those delicate machines, without which we would not have been able to continue the war.

"One of your most important duties is to supply all the Allies with materials, and I feel sure that your work will be well done."

Captain Horowitz declared that the word "engineer" is a synonym for efficiency, and that efficiency must guide every action taken by the citizens of this country, so that all our resources may be used to the best advantage.

President Hollis was also among the speakers and said on behalf of the United States:

"Many of the young men have asked me during the last few weeks how they could do their share. Our country must provide a man for every place, and we must have an agency of the Government to allot the men to the places where they can best serve. We serve best, in this funeral procession on the way to the burial of the divine right of kings, when we fit into the place where we can do the most good."

Professor Van Hecke closed the evening with a vivid portrayal of the part Belgium has played in the war.

Spring Meeting of Boston Section

THE Spring Meeting of the Boston Section of the American Society of Mechanical Engineers was held on Thursday afternoon and evening, May 17, 1917.

It was originally planned to make this a machine-tool meeting, but the crisis in the life of the country made it appear that a staid, theoretical discussion would be rather out of place at the present hour. The program was therefore devoted to one of the most vital subjects in the scheme of National Defense: namely, heavier-than-air flying machines.

In the afternoon the Section, on special train, visited the works of The Burgess Company at Marblehead, Mass., where the visitors were shown about the plant and given very frank and thorough explanations by the engineers of the company.

The Burgess Company was originally started by Mr. Burgess to manufacture, in this country, the Dunn self-stabilizing aeroplane, but is now making aeroplanes for The Curtiss Company, practically exclusively on orders from the Federal Government and units affiliated with it.

The visiting engineers were shown all over the place, and had a chance to inspect, both in their final shapes and in various stages of construction, hydroaeroplanes and land machines of various types. In the water, just ready to start for its altitude test previous to acceptance by the Federal Government, was a huge Dunn-type hydroaeroplane specially built for carrying out experiments with the John Hays Hammond method for the wireless direction of torpedoes. And right by, in the shed, suspended from the ceiling, was what is probably the smallest seaplane in the world, a tiny machine in which every other consideration except safety is sacrificed for speed, and which can develop 95 miles an hour without much trouble.

While the explanations were given by Mr. Russell, Engineer of the Burgess Company, and various questions of the members answered, a big Dunn machine appeared in the air and circled overhead at a speed estimated at about 70 miles an hour. The interesting feature of that particular flight was the fact that, as stated by Mr. Russell, the pilot in it had only three hours of preliminary training.

The evening program comprised the meeting of the Section at Wentworth Institute, Boston, Prof. A. L. Williston, Mem. Am.Soc.M.E., in the chair.

Maj. W. P. Wooten, of the Corps of Engineers, U. S. A., was scheduled to speak, but was prevented through illness, and instead Judge M. J. Murray gave an impassioned talk on national unpreparedness, the conditions which confronted the United States expeditionary force in Mexico, and which confront its military establishment now. In conclusion, he called upon the engineers to stick to their work, but at the same time try to acquire the information which would prove useful to them, if called to actual service.

This address was followed by a talk on Wings for the American Eagle, by W. B. Stout, Chief Engineer, Aircraft Division, Packard Motor Car Company, Detroit. Mr. Stout called attention to the great change which the automobile wrought in the state of mechanical education of the average public. Twenty years ago the average man hardly knew what a monkeywrench was used for, and let his wife oil the sewing machine. At present, there are actually in the country hundreds of thousands of men in various walks of life who can understandingly take care of the rather complicated mechanical and electrical equipment of an automobile. The automobile not only educated the public in the fundamentals of machinery, but also taught alertness to men who were formerly largely dreamers. The aeroplane is going to continue what the automobile began and, in fact, is already teaching its users entirely new conceptions of space and motion. Man is rapidly becoming a real three-dimensional being; and as the speaker expressed it, a new heaven is being opened through the aeroplane, just as a new earth was made by the automobile.

In the course of his address Mr. Stout gave some interesting statistical data on the present aircraft activities in Europe. He stated that aeroplanes are now made to climb steadily at the rate of 1000 ft. per min. and upward and there is in the field a small Italian machine which can climb at an angle of 45 deg. The development of aeroplane construction is so rapid that a new type of aeroplane is created on the average of about every eleven weeks, and it is by no means rare that when a batch of machines come from the factory, on orders placed only three or four months before, the planes are found to be antiquated to such an extent that they are simply burned up without being used at all. The production of machines has reached the impressive figure of 1000 machines a week, and the only real limitation to a still greater production is the problem of the engines.

Coöperation with Bureau of Mines

The Society's Standing Committee on Research has been appointed a Special Advisory Committee of the U. S. Bureau of Mines, and the following Sub-Committees have also been appointed to coöperate with the Bureau:

Sub-Committee on Mining Equipment:

FREDERICK K. COPELAND, *Chairman*, President, Sullivan Machinery Company, 122 S. Michigan Ave., Chicago, Ill.

FRANK H. ARMSTRONG, Mechanical Engineer, Penn Iron Mining Company, Republic Iron Company, Vulcan, Michigan.

DOUGLAS BUNTING, Chief Engineer, Lehigh & Wilkes-Barre Coal Co., Wilkes-Barre, Pa.

Sub-Committee on Fuels:

CHARLES RUSS RICHARDS, Professor of Mechanical Engineering, University of Illinois, Urbana, Illinois.

JOSEPH HARRINGTON, Advisory Combustion Engineer, 208 S. La Salle St., Chicago, Illinois.

CHARLES J. BACON, Engineering Department, E. I. du Pont de Nemours & Co., Wilmington, Delaware.

ROLL OF HONOR

THE Committee on Engineer Officers' Reserve Corps, now the Committee on National Defense, has just issued to the membership two circulars giving instructions to those who contemplate offering their services in the Army and Navy. The Committee requests that those members who apply for appointments in the national service, report this fact to the Society, so that their names may be included in the Roll of Honor and so that the Committee may keep track of the men.

Last month we published the first list of those members of the Society who had enlisted in the national service, and we supplement that with the following names since received:

BARKER, GEORGE S., Coast Artillery, Officers' Reserve Corps.*
BELCHER, P. W., First Lieutenant, Engineer Officers' Reserve Corps.
CATTELL, WILLIAM A., Major, Engineer Officers' Reserve Corps.
CAMPBELL, E. D., Captain, Engineer Officers' Reserve Corps.
CONARD, FREDERICK U., Second Lieutenant, Engineer Officers' Reserve Corps.
CRONEMEYER, HENRY C., Captain, Engineer Officers' Reserve Corps.*
ENNIS, WILLIAM D., Major, Officers' Reserve Corps (Ordnance Dept.).
FARRINGTON, THOMAS H., Captain, Engineer Officers' Reserve Corps.*
FRANCIS, HARRIS S., Lieutenant, Engineer Officers' Reserve Corps.*
GLENN, EDWARD R., First Lieutenant, Engineer Officers' Reserve Corps.*
HARRIS, MURRAY W., Ordnance Dept., Officers' Reserve Corps.*
HECHLER, F. G., Mechanical Engineer, United States Naval Engineering Experiment Station, Annapolis, Md.
HILL, EDWARD L., Captain, Engineer Officers' Reserve Corps.*
HOBART, J. C., JR., First Lieutenant, Engineer Officers' Reserve Corps.*
HOLCOMBE, AMASA M., Captain, Officers' Reserve Corps.
HULBURT, WYNNE D., Second Lieutenant, Engineer Officers' Reserve Corps.*
JONES, REID, Captain, Engineer Officers' Reserve Corps.*
LACY, ROBERT, Captain, Engineer Officers' Reserve Corps.*
LEISTNER, AUGUST, First Lieutenant, Engineer Officers' Reserve Corps.*
LONN, J. M., Reserve Officer, Engineer Officers' Reserve Corps.*
MCNEAL, D. RAYMOND, Engineer Officers' Reserve Corps.*
MERKT, THEO. B. J., Ordnance Dept., Officers' Reserve Corps.*
MULLER, RAYMOND W., Mechanical Engineer, Engineer Officers' Reserve Corps.*
RATHJENS, GEORGE W., Captain, Engineer Officers' Reserve Corps.
RHYS, C. O., Captain, Engineer Officers' Reserve Corps.*
ROSS, HENRY B., First Lieutenant, Engineer Officers' Reserve Corps.*
STREETER, ROBERT L., Major, Officers' Reserve Corps.*
STUART, THOMAS E., Central Department, Engineer Officers' Reserve Corps.*
TAYLOR, CHARLES F., First Artillery, Officers' Reserve Corps.
THORNHILL, THEODORE W., First Lieutenant, Engineer Officers' Reserve Corps.*
TRIMMER, JAMES W., Ensign (Engineer), U.S.N.R.F., Class 2.
VAN VALKENBURGH, MERRITT, Ordnance Dept., Officers' Reserve Corps.*
WEINBERG, GEORGE S., Major, Engineer Officers' Reserve Corps.*
WIEBER, GEORGE A., Second Lieutenant, Officers' Reserve Corps.*
WILBER, DANA W., Captain, Engineer Officers' Reserve Corps.
YODER, THOMAS M., Captain, Officers' Reserve Corps.

Our Members and National Service

The members of this Society, in common with those of the three other Founder Societies, received during the past month from the Joint Engineer Committee on National Defense, formerly the Joint Committee on Engineer Reserve Corps, two pamphlets instructing them how best to apply for service in the military and naval forces of the United States.

Reviewing the pamphlet describing the Army service, it appears that the general place for the members of our Society is as officers in the Ordnance Department of the Officers' Reserve Corps, as the following extracts show:

ORDNANCE DEPARTMENT

Officers of the Ordnance Department of the Army are mechanical engineers especially trained for the production of war munitions. The Department offers one of the best fields in which mechanical engineers can serve as reserve Ordnance officers in the Officers'

* Acceptance of commission pending at date of latest list from War Department.

Reserve Corps. In addition to mechanical engineers, chemists and metallurgical engineers will be of great assistance to the Department in the event of war. The following may therefore be of interest in this connection:

Although the project has not yet taken definite form, it is hoped that reserve Ordnance officers may be divided into groups, each group being identified with some particular arsenal which will become, as it were, the home station of that group, to which arsenal they will probably be assigned during the active period of instruction.

The Ordnance Department is charged with the duty of procuring by purchase or manufacture and distributing the necessary ordnance and ordnance stores for the Army and the Organized Militia and for this purpose establishes and maintains arsenals and depots for their manufacture and safekeeping.

Ordnance and ordnance stores include cannon and artillery vehicles and equipments, such as the great guns used in the seacoast defenses, with their carriages, as well as the lighter guns used by the mobile artillery; apparatus and machines for the service and maneuver of artillery; small arms, ammunition, and accoutrements, horse equipments and harness for the artillery, and horse equipments for cavalry and for all mounted men except those in the Quartermaster Corps; tools, machinery, and materials for the ordnance service; and all property of whatever nature supplied to the military establishment by the Ordnance Department.

The duties of Ordnance officers are generally those connected with the direction, management, control and supervision of the work of manufacture, test and repair of ordnance and ordnance stores at manufacturing arsenals and depots, with the issuing and receiving of such supplies and with the inspection and test of such materials when purchased by contract.

Applicants for the Officers' Reserve Corps, Ordnance Section, desiring technical duty should have both a theoretical and practical knowledge of steam boilers, engines, shop tools, including the handling of such tools; electricity and electrical machines, particularly dynamos and motors; and experience in the manufacture of articles composed of steel, of wood, and of leather.

They should have had practical experience in the management of shops and the handling of operatives. Their experience should also be such as to enable them to take up the work of inspection of all classes of ordnance stores if manufactured by private concerns under contract, to insure that such materials are of standard design and workmanship and in accordance with Ordnance Department drawings and specifications.

Full information regarding the Corps, may be obtained from the Adjutant General, United States Army, Washington, D. C., as the pamphlet states.

The booklet describing service in the Navy states that members of the engineering societies are probably best fitted to serve in the Naval Coast Defense Reserve, full particulars of which are given in a pamphlet entitled Circular Relating to Enrollment in the Naval Coast Defense Reserve, to be obtained by addressing the Commandant of any Naval District.

The U. S. Bureau of Mines, in coöperation with the American Institute of Mining Engineers and the American Chemical Society, has undertaken a census of mining engineers, metallurgists and chemists with a view of ascertaining the qualifications of each and the line of work in which each can be of the most service to the country in time of emergency. The classification will embrace 27 specific groups of industrial chemists, 16 groups of engineering specialists, and 15 groups in the metallurgical field. By such minute classification the bureau will be in a position to furnish on short notice the names of specialists for service under the classification, so that in case of necessity these technical men can be available to industrial plans where they would be of most assistance to the country. European experience has shown that nothing is more important in time of national emergency than a knowledge of the qualifications and experience of expert technical men.

Request for January Issues

The demands for copies of the January 1917 issue of THE JOURNAL, which contains a full account of the 37th Annual Meeting, have now exceeded the supply, and this issue is temporarily out of stock. Requests for copies are still being made, however, and members who do not desire to preserve permanently their copy of the January JOURNAL are requested to return it to the Secretary, who will remit postage and cost to them.

Commission on Gunmounts

The following is the personnel of the Commission to determine the style on gunmounts for the U. S. Army: Gen. Joseph E. Kuhn (of the Line), President of the War College; Col. Charles B. Wheeler from the Ordnance Department, formerly head of the Watertown Arsenal; two representatives of the Coast Artillery, Major John W. Gulick from Fortress Monroe and Capt. Walter R. Wilson; representative from the Navy, Capt. Charles P. Plunkett; the two civilian appointees from the Am.Soc.M.E., Dr. Ira N. Hollis and Dr. D. S. Jacobus.

In an editorial under date of April 12, 1917, the *Iron Age* discusses the utilization of slags from steel-making processes. From statistics adduced it appears that each year in the United States over 2,000,000 tons of basic slag is obtained from basic open-hearth steel furnaces, and in this slag is contained not less than 111,000 tons of oxide of manganese.

The loss is estimated by one producer to amount to $8 per car for each car dumped, or a total loss of $320,000 per year if all the country's basic slag is discarded; and when it is recalled that the railroads now charge for removing all slags this matter becomes still more serious. The value of acid slag is much less.

The utilization of slag in blast-furnace burdens appears to be promising, but the writer does not think much of the use of slag as a source of metallic manganese or substitute for ferromanganese.

Lawrence V. Benet, Mem.Am.Soc.M.E., vice-president of the Société Anonyme des anciens Etablissements Hotchkiss & Cie., Paris, France, is coming to this country as the representative of the American Chamber of Commerce in Paris, of which he is president. He is accompanying M. André Tardieu, the newly appointed French High Commissioner to the United States, who has gathered elaborate statistics of the requirements of France for presenting detail information to the American authorities. M. Benet is the Paris representative of our Special Committee on International Standard Pipe Threads.

Construction of a new building for the Engineers' Club, Dayton, Ohio, will be begun shortly and is expected to be finished by January 1. It will cost about $170,000, of which $130,000 is for the building alone. It will be two stories high, with basement, of Georgian design, of buff gray brick and with carved stone trimmings.

Oil engines working at high altitudes cannot develop the same power as at sea level owing to the smaller weight of oxygen contained in the cylinder.

The Use of Bessemer Steel Boiler Tubes as a Substitute for Tubes of Open-hearth Steel as Required by the A. S. M. E. Boiler Code

AS a result of the unprecedented demand for steel and its present scarcity, efforts have been made to provide for the use of boiler tubes manufactured of bessemer steel in place of the open-hearth steel tubes as required by the A.S.M.E. Boiler Code. The National Tube Company, in a letter addressed to the trade early in March, requested that wherever possible bessemer steel tubes be used in place of those made of open-hearth steel in order to relieve the pressure of demand upon this latter material. It was pointed out in this letter that the present industrial situation has led to a demand for tubes of the open-hearth material which had grown to such an extent that the company was nearly two years behind in its orders, and the use of bessemer steel was suggested as a means of relief.

The impression was given that this was an attempt to replace the material required by the Boiler Code by an inferior material. The matter was brought before the Council of the Society at a meeting on March 16, with the result that a Committee was appointed to confer with the National Tube Company. This Committee consisted of the following members:

Ira N. Hollis, President, American Society of Mechanical Engineers.

Charles S. Blake, Hartford Steam Boiler Inspection & Insurance Co.

J. B. Ennis, American Locomotive Co.

E. R. Fish, Heine Safety Boiler Co.

F. R. Hutton, American Museum of Safety (Member of Council).

Julian Kennedy, Member of Council.

Frank E. Law, The Fidelity & Casualty Co.

J. W. Lieb, National Electric Light Assn.

Geo. A. Orrok, National Electric Light Assn.

W. M. McFarland, Babcock & Wilcox Co.

H. deB. Parsons, Consulting Engineer (Member of Council).

James Partington, American Locomotive Co.

H. V. Wille, Baldwin Locomotive Works.

Dr. Hollis appointed Mr. H. deB. Parsons Chairman of the Committee.

Meetings were held by this Council Committee in conference with officials of the National Tube Company in which the entire situation was thoroughly canvassed and efforts were made to outline a proper solution of the problem. The Council Committee pointed out the unquestionable advantages of open-hearth steel as compared with bessemer steel for use in boiler tubes, and urged upon the Company the necessity of exerting its greatest effort to cope with the situation. Inasmuch as the National Tube Company had been instrumental in assisting to develop the present boiler-tube specifications contained in the Code, and as these specifications had been found to work out satisfactorily, it was felt that to abandon the requirement of open-hearth steel would be a retrograde movement. The officials of the National Tube Company explained that this suggestion was merely an effort on their part to point out a means of relief for those cases where it could be taken advantage of without conflicting with rules or requirements based on the A.S.M.E. Code. This statement was supplemented by one to the effect that efforts were being made to rush to completion additional open-hearth-steel furnaces which would undoubtedly be in operation in the middle of the summer and which would then greatly increase the open-hearth-tube-producing capacity of their works. It was further stated that the tube-manufacturing capacity of the Company was far in excess of the capacity of their sources of material supply.

The result of the conferences was a thorough understanding between the National Tube Company and the Council Committee relative to the situation. Assurances were given that there was no intent to sell tubes of bessemer material with the claim that they conform to the specifications of the A.S.M.E. Boiler Code, and a circular letter was drafted by the National Tube Company to be sent out by its branch offices to counteract any erroneous impression that may have been given. The letter was submitted to the Council Committee and with slight modifications it was agreed to by the Committee and was finally approved by the Council in the following form:

NATIONAL TUBE COMPANY
Pittsburgh, Pa.

April 16, 1917.

Circular Letter No. 857

TO MANAGER OF SALES.

GENTLEMEN:

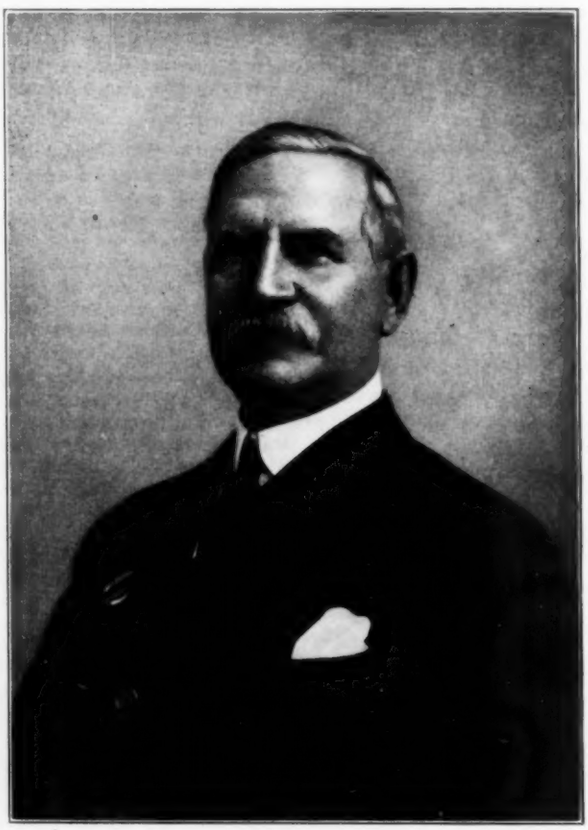
As you are aware, about four years ago we decided to in future manufacture all of our boiler tubes from open hearth steel. This action was taken because our experience had taught us that for locomotive boilers and for water tube boilers the open hearth steel tube was better than the Bessemer steel tube. For fire tube boilers we have never had any experience that leads us to believe one is any better than the other, but in order that our output might be satisfactory for all purposes we decided to make all tubes from open hearth steel. Later on a code was prepared by The American Society of Mechanical Engineers covering this whole question both as to material and gage. We gave our hearty coöperation to this Society to bring about the change which they proposed, and we have been coöperating with them in the various states so that this code should be the universal code throughout the United States, it being our firm conviction that boilers with all their appurtenances made under the code of that Society are preferable to those made under any other code heretofore in use. A situation has now arisen due to the war in Europe that has made it impossible for us to secure enough open hearth steel for this purpose, and we are pressed as never before for delivery of tubes. Up to the present moment we have endeavored to supply ourselves with enough open hearth steel to fill our orders for locomotive tubes and for tubes for water tube boilers, and have succeeded fairly well. We have been obliged, however, to ask many of our customers, who insisted upon deliveries that we could not make if we depended upon open hearth steel, to accept tubes made from Bessemer steel so that we could give the greatest possible service in enlarging the power of the country. The information regarding our desire to supply Bessemer steel tubes where the customer would agree to it has not been conveyed generally in the same manner, and an impression has gotten abroad that we are endeavoring to avoid the code of the A.S.M.E. and is causing us some embarrassment as well as the members of that Society. I wish therefore that you would issue this letter verbatim in circular form to your customers, one and all, that each may understand the situation just as it is. If they do, we feel quite sure that, where they are not called upon to supply boilers in accordance with the A.S.M.E. Code, they would readily agree to accept Bessemer, and if they do it will enable us, until we can supply ourselves with a full amount of open hearth steel, to run our furnaces full and for the general good. Just when we will be able to go back fully to the use of open hearth in the manufacture of boiler tubes I am unable at this writing to say, but we are rushing the construction of some additional open hearth furnaces and if nothing unforeseen occurs we expect by July to be able to supply our requirements, and if so we shall do so because we believe it altogether the best practice.

Yours truly,

1st Vice-President.

WILLIAM LODGE

WILLIAM LODGE, President of the Lodge & Shipley Machine Tool Company, of Cincinnati, Ohio, passed away at his home on Monday, April 30. His death was sudden and came as a great surprise to his many friends, since less than a week before he was in attendance at the annual convention of the National Metal Trades Association in New York City, where as usual he was one of the leading spirits.



Wm Lodge

Mr. Lodge was born in Leeds, England, in 1848, the son of George Lodge, a skilled mechanic in the textile industry. He had the advantages of what we call a common school education. After serving his apprenticeship in the shops of Fairbairn & Company, Leeds, he came to Philadelphia, where he worked for Chambers Brothers from 1869 to 1872, making paper-folding machinery. He came to Cincinnati in 1872 and worked for Steptoe, McFarlan, Nottingham & Co. for eight years, first as a journeyman machinist and later as a foreman. Having saved $1,000, he formed a partnership with William Barker, under the title of Lodge & Barker, at Fifth street at the junction of the C. H. & D. tracks, and they started in business the first day of January, 1880. Associated with them for a short time was Mr. Beehle, another Steptoe workman. Their first task was to true up a few second-hand machines which they had bought, and since they had no one in their employ, they were obliged both to secure their own orders and to execute them. Part of this first business was making some opening dies for Powell and a small turret lathe for the Lunkenheimer Company. The latter immediately ordered three more, and during the following year eighteen lathes were made and sold. Beginning with $1,000, the business inventoried at the end of the first year $7,000; at the end of the second year $32,000; and at the end of ten years $400,000. Fifteen months after starting they employed 75 men. There is little doubt that this rapid success induced quite a number of the better and more ambitious mechanics in Cincinnati to take up similar work. Mr. Lodge was well known among the mechanics of the city and had been president of their union. If one of their number could build up a successful business, why could they not do the same? Some of the best known of the Cincinnati tool-building firms were established during the few years after Mr. Lodge's start.

In 1886 Mr. Barker sold his interest to Charles Davis. Lodge and Davis continued in partnership until 1892, when Mr. Lodge severed his connection with the firm and it later became the American Tool Works. They were employing at that time between 300 and 400 men. Mr. Lodge, in March, 1892, organized the Ohio Machine Tool Company, and in August, 1892, became associated with Murray Shipley, forming the present The Lodge & Shipley Machine Tool Company.

Mr. Lodge's first export order was received in 1889. Alfred Herbert, who had just started in Coventry, sent an inquiry in regard to drill presses to Cincinnati, which was forwarded to Mr. Lodge in London. Mr. Lodge went down to see him and asked whether the inquiry was for the purposes of information or for purchase. Mr. Herbert said that if Lodge had a better machine he would buy. Mr. Lodge asked to see his machine and after a little hesitation he was taken out into the shop. The first machine he saw was a planer. He said he could save thirty per cent on the work as it was being done, and would sell them a machine which would do it for £100. He was told that the planer they were looking at cost only £65, and replied that that was all it was worth. He spent several hours in the shop and left the plant not only with an order but with the check in payment thereof. This was the beginning of a large export business.

While the firm was Lodge & Davis, it built lathes, planers and drill presses. Mr. Lodge wanted to manufacture rather than build, and to specialize upon lathes. Mr. Davis, who was a business man, wanted a complete line of tools, as he saw the opportunity of selling other machines with the lathes. This led to the policy of concentrating upon the manufacture of engine lathes, and placing orders for other types of tools with mechanics just starting up, or with workmen from their own plant whom they helped to start in business. For instance, to Smith & Mills, who had been foremen with John Steptoe and had started making set screws and cap screws, they gave an order for 300 shapers. To R. K. LeBlond, who had served his apprenticeship with Brown & Sharpe Manufacturing Co., and had come to Cincinnati to make printers' machinery and supplies, Lodge & Davis gave a large order for slide-rests. To William Owen, one of their workmen, they gave an order for Fox monitors. Owen went into partnership with Philip Montanus and started the Springfield Machine Tool Company, and Lodge & Shipley bought their entire product for eight years. Through Mr. Lodge's influence, Frank Kempsmith came from Warner & Swasey as one of the partners in this firm. He afterwards moved to

Milwaukee and started the Kempsmith Manufacturing Company.

Mr. Lodge had, during his apprenticeship in the shops of Fairbairn & Co., where specialization of manufacture was carried out to a marked degree, completely absorbed the idea of the manufacture of machinery in large lots. He was particularly well known for the fact that he was one of the first, if not the first, to specialize in the manufacture of one type of machine tool only, instead of making a few of many kinds of machine tools.

Some of the firms whose principals have in one way or another been associated with Mr. Lodge are the Fosdick Machine Tool Company, Boye & Emmes Machine Tool Company, Dreses, Mueller and Company and the Cincinnati Planer Company.

Mr. Lodge was a member of The American Society of Mechanical Engineers for 27 years, was a member of the Engineers' Club of Cincinnati, the Machinery Club of New York, the Ohio Manufacturers' Association and various other organizations; and was especially active in the National Metal Trades Association, of which he was treasurer for three years. He was one of the organizers of the National Machine Tool Builders' Association and served as its president for two years.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER JULY 10, 1917

THE American Society of Mechanical Engineers is an organization for mutual service of over 7800 engineers and associates coöperating with engineers. The membership of the Society comprises Honorary Members, Members, Associates, Associate-Members and Juniors, all elected by ballot of the Council. Application for membership is made on a regular form furnished by the Secretary which provides for a statement of the standing and professional experience of the applicant and requires references from voting members personally acquainted with the applicant. The requirements for admission to the various grades will be furnished upon request.

Below is the list of candidates who have filed applications for membership since the date of the last issue of The Journal. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate-Member or Junior, and those in the third under Junior grade only. Applications for change of grading are also posted.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by July 10, 1917, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about August 15, 1917.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be somewhat slower than under normal conditions. The first step in the consideration of an application is taken by the Membership Committee, and this committee is composed of busy men, with fewer opportunities to meet together in these strenuous times.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

California

HANSON, FRED P., Shop Superintendent and Engineer, American Gold Dredging Co., Oroville

KEY, JAMES F., President, Key Adding Machine Co., Los Angeles

KILGORE, EDWIN R., Division Superintendent, Pipe Line Department, Standard Oil Co., Patterson

LAMPMAN, JAY B., Assistant General Sales Manager, Worthington Pump & Machinery Corp., Los Angeles

ROLPH, GEORGE M., General Manager, California & Hawaiian Sugar Refining Co., San Francisco

Colorado

SALISBURY, ROYAL D., Consulting Engineer, Denver

Connecticut

ANDERSON, ROBERT E., Production Engineer, Winchester Repeating Arms Co., New Haven

BLAKESLEE, RUSSELL C., Mechanical Superintendent, Chase Metal Works, Waterbury

DART, HARRY E., Superintendent Engineering Department, The Hartford Steam Boiler Inspection & Insurance Co., Hartford

HENDERSON, GEORGE A., Foreman, Emergency Machine Shop, Winchester Repeating Arms Co., New Haven

KANN, H. E. ARTHUR, Tool Department, Winchester Repeating Arms Co., New Haven

Georgia

KLEIN, EDWARD W., Heating Engineer, Bishop Babcock Becker Co., Atlanta

Illinois

McELROY, JOSEPH W., Commercial Sales Engineer, Westinghouse Elec. & Mfg. Co., Chicago

NOLTE, CHARLES B., Mechanical Engineer, Robert W. Hunt & Co., Chicago

SAVERY, THOMAS H., JR., Consulting Engineer, Chicago

SHIELDS, HARRY C., Western Sales Engineer, Fuller Engineering Co., Chicago

WEBER, FRANK E., Industrial Engineer, Chicago

Indiana

GRIMES, ORA L., Engineer and Superintendent, Johnson & Miller, Archts., Terre Haute

Kentucky

HOUSTON, HERMAN M., Secretary and Treasurer, The Houston Stanwood & Gamble Co., Covington

Louisiana

MOODY, HOWARD N., Contracting Engineer, New Orleans

Massachusetts

CHAPMAN, Albert P., Superintendent Power and Repairs, Ludlow Mfg. Associates, Ludlow

HEALD, JAMES N., Treasurer and General Manager, The Heald Machine Co., Worcester

MARTIN, GEORGE R., Assistant General Manager, American Steam Gauge & Valve Mfg. Co., Boston

Michigan

HEWITT, RICHARD B., Secretary-Manager, General Fire Extinguisher Co., Detroit

MEDHURST, ARTHUR W., Assistant General Factory Manager and Mechanical Engineer, Anderson Electric Car Co., Detroit

SQUIRES, JOHN, Consulting Engineer,
Signal Motor Truck Co., Detroit

Minnesota

EMERSON, GEORGE H., General Manager,
Great Northern Railway Co., St. Paul

Missouri

BATEMAN, PAUL, Assistant Chief Estimator,
American Car & Fdy. Co., St. Louis
LILJEGREN, GUNNAR O., Manager Sprinkler Department,
Urbauer-Atwood Heating Co., St. Louis

New Hampshire

FLATHER, ERNEST J., President and Treasurer,
E. J. Flather Mfg. Co., Nashua
TILTON, HENRY B., Superintendent and Works Manager,
Morley Button Mfg. Co., Portsmouth

New Jersey

ACKERMAN, ALBERT A., JR., Chief Draftsman,
The Singer Manufacturing Co., Elizabethport
BROWN, ALBERT T., Engineering Assistant, Mechanical Dept.,
Public Service Elec. Co., Newark
BURDICK, HERBERT, Designing Engineer, Chief Draftsman,
DeCamp & Sloan, Inc., Newark
HOWARD, ARTHUR E., Manager Rate Service Dept.,
T. A. Edison Affiliated Interests, Orange
MUSSO, ALFRED, Factory Consulting Engineer,
Edison Battery Co., Orange
PATTERSON, EDGAR H., Assistant to Chief Engineer,
New York Shipbuilding Corp., Camden

New York

CHAMBERLAIN, WILLIAM T., Chief Draftsman,
Standard Aniline Products, Inc., Wappingers Falls
HALL, CHARLES R., Manager Mechanical Sales Dept.,
Diamond Rubber Co., New York
LAENCHER, FREDERICK W., Chief Engineer,
W. C. Ritchie & Co., Brooklyn
LOCKWOOD, MARQUIS H., Mechanical Expert and Patent
Attorney, New York
MANNING, JAMES H., Superintendent Motive Power,
The Delaware & Hudson Co., Watervliet
MULCARE, JAMES J., Assistant Engineer in Charge Drafting
Dept., General Electric Co., Schenectady
QUIRK, CLINTON H., Engineer,
Howard & Morse, New York
ROBINSON, THOMAS R., Engineer,
W. S. Barstow & Co., Inc., New York
ROWLAND, GEORGE R., Supervising Engineer, Lubricating Div.,
The Texas Co., New York
STAFFORD, HAL R., Mechanical Engineer,
Economy Devices Corp., New York
STRATTON, DAVID V., Production Manager,
Pyrene Manufacturing Co., New York

North Carolina

STATES, LOUIS A., Consulting Engineer, Gastonia

Ohio

GORDON, BYRON B., Scale Inspector,
Pennsylvania Lines West, Columbus
SHIPLEY, MURRAY, Vice-President and Secretary,
The Lodge & Shipley Mch. Tool Co., Cincinnati
SNYDER, HERBERT W., Assistant to Vice-President,
Lima Locomotive Works, Inc., Lima

Pennsylvania

BOYD, FRANK F., Consulting Engineer,
Ballinger & Perrot, Philadelphia
CHURCH, ARTHUR L., Assistant to President,
The Baldwin Locomotive Works, Philadelphia
HAARBYE, STORM B., Assistant Engineer,
American Sheet & Tin Plate Co., Pittsburgh
JAMES, RICHARD L., Constructor,
The United Gas Improvement Co., Philadelphia
KENYON, JOHN T., Consulting Rifle Expert,
Remington Arms Co., Delaware, Eddystone
LAWRENCE, JOHN S., Manufacturing Superintendent, Erie Works,
General Electric Co., Erie
LINNING, FRANK, Works Manager,
Tacony Steel Co., Tacony
MAHONEY, JOSEPH N., Engineer with
Westinghouse Elec. & Manufacturing Co., Pittsburgh
RASCHE, CHARLES M., Superintendent Toolroom,
Remington Arms Co. of Del., Eddystone
SELKIRK, WILLIAM M., Chief Engineer,
Pittsburgh Steel Products Co., Monessen
STETSON, JOHN B., JR., President,
Defiance Manufacturing Co., Philadelphia

Utah

LEDDELL, WILLIAM A., Engineer,
United States Smelting, Refining & Mining Co., Salt Lake City

Virginia

MASI, FRANK H., President & Treasurer,
Atlantic Iron Works, Inc., Norfolk

Vermont

LOVEJOY, FRED P., President,
Lovejoy Tool Co., Inc., Springfield

Wisconsin

CORWIN, LLOYD A., Efficiency Engineer,
Four Wheel Drive Auto Co., Clintonville

Canada

MACDOUGALL, GEORGE D., Chief Engineer,
Dominion Iron & Steel Co., Sydney, N. S.
MELDRUM, MALCOLM R., General Manager,
The Herbert Morris Crane & Hoist Co., Ltd., Toronto
PAIGE, JAMES F., General Manager,
Port Arthur Shipbuilding Co., Ltd., Port Arthur, Ont.

Hawaii

RAMSAY, WILLIAM A., Manager,
Catton, Neill & Co., Ltd., Honolulu

FOR CONSIDERATION AS ASSSOCIATE-MEMBER OR JUNIOR

California

GUHA, KAMINI K., Student, University of California, Berkeley
KASPAR, JOSEPH J., Structural Engineer,
Llewellyn Iron Works, Torrance

Connecticut

BANKS, FREDERICK R., Engineer of Equipment (Commercial
Division) Remington Arms,
U. M. C. Co., Bridgeport

Illinois

CHEYNEY, CHARLES C., Engineer and Manager Chicago Office,
Buffalo Forge Co.,
Carrier Air Conditioning Co., Chicago
MILLER, EWELL B., Department Head,
Western Electric Co., Inc., Hawthorne

Massachusetts

BLAKELEY, GERALD W., Power Specialties Engineer,
H. W. Johns-Manville Co., Boston
BROUILLETTE, ALBERT V., Engineer,
New England Westinghouse Co., Chicopee Falls
GREENWOOD, TALMA T., Patent Solicitor,
With B. J. Noyes, Boston
HART, LEON A., Industrial Engineer,
N. E. Westinghouse Co., Chicopee Falls
STRICKLAND, FRANK S., Rate Department,
N. E. Westinghouse Co., Springfield

Missouri

AYCOCK, ROBERT V., Proprietor,
R. V. Aycock & Co., Kansas City
DOLL, WILLIAM E., Engineering Salesman,
Henry R. Worthington, St. Louis

New Jersey

DRAKE, CHARLES L., Sales Engineer,
S. K. F. Ball Bearing Co., Newark
HOPKINS, GEORGE J., Mechanical and Industrial Engineer,
The Celluloid Co., Newark
MEHR, JOSEPH, Fuel Inspector,
Public Service Electric Co., Newark

Nevada

GIGNOUX, FRANK C., Master Mechanic,
Seven Troughs Coalition Mining Co., Seven Troughs
MARTIN, HENRY, JR., Assistant Professor Mechanical Engineering,
University of Nevada, Reno

New Mexico

HARLEY, GEORGE T., Efficiency Engineer,
Burro Mt. Copper Co., Tyrone

New York

BRAYTON, HAROLD M., Student Mechanical Engineering,
Mass. Inst. Tech., Syracuse
CLENDON, GEORGE W., Mechanical Engineer,
Locomotive Pulverized Fuel Co., New York
DEXTER, HARRIS E., Resident Managing Engineer,
Sprague Electric Section Ind. Control Dept., General Electric
Co., Schenectady
MINICH, HENRY D., Consulting Engineer, Troy
REYNOLDS, GEORGE B., Industrial Engineer,
Eastman Kodak Co., Rochester
SAXBY, LEWIS E., Mechanical and Electrical Engineer,
Standard Oil Co. of N. J., New York
SCHWARTZ, ERNEST, Assistant Chief Draftsman,
McGraw-Hill Publishing Co., Inc., New York
SMITH, ALBERT C., JR., Draftsman,
Combustion Engineering Corp., New York
STITZER, ARTHUR B., Chief Engineer,
Republic Railway & Light Co., New York

Ohio
BOWMAN, ROBERT B., Factory Representative,
The White Co., Cleveland

Pennsylvania
CURLY, RAYMOND E., Superintendent Artillery Case Shop and Mechanical Engineer,
Frankford Arsenal, Frankford
PRITCHETT, CARL E., Heating and Ventilating Engineer,
Westinghouse Elec. & Mfg. Co., E. Pittsburgh

Texas
TOMPKINS, H. K. V., Chief Engineer,
Texas Gas & Electric Co., Houston

Wisconsin
WOLLENSAK, H. P., Sales Engineer,
Wisconsin Motor Mfg. Co., Milwaukee

Wyoming
SQUIRES, JESSE C., Mechanical Engineer,
Wyoming Electric Co., Casper

FOR CONSIDERATION AS JUNIOR

Alabama
BOYD, WALTER R., with
Worthington Pump & Machinery Corp., Birmingham

California
MOORHEAD, ARCHIBALD C., Engineering Corp.,
Richmond Refinery, Standard Oil Co. of Cal., Richmond

Connecticut
PETERSON, JOHN W., Tool and Machine Designer,
The Harris Engineering Co., Bridgeport
SHELDON, JAMES R., JR., Apprentice in Mech. Engrg.,
Waterbury Clock Co., Waterbury
TAYLOR, EDWARD N.,
With Winchester Repeating Arms Co., New Haven

Cuba
GIANELLONI, VIVIAN J., General Superintendent,
Central Florida, Compania Azucarera, Florida, Camaguey

Illinois
COOPER, HOWARD, Lubrication Engineer,
The Texas Co., Chicago
PLOCINSKY, ABE J., Student,
Armour Institute of Technology, Chicago
REYMOND, MARTIN H., with Western Electric Co., Chicago
VANDEN BOOM, BERRY C., Installation Sales,
The Prest-O-Lite Co., Inc., Chicago

Indiana
LONN, JULIUS M., Mechanical Engineer,
Great Western Mfg. Co., La Porte

Maine
TUTTLE, GEORGE W., Assistant Mechanical Superintendent,
Eastern Mfg. Co., Lincoln

Massachusetts
BOSNIAN, LUTHER H., Assistant to Consulting Engineer,
New England Westinghouse Co., Springfield
BROWN, WILLIS C., Engineer-Salesman,
The Foxboro Co. Inc., Foxboro
CLAUSSEN, HOWARD P., with Bemis Bro. Bag Co., Boston
COLE, RAYMOND A., Designer,
New England Westinghouse Co., Springfield
DROBISCH, RAYMOND W., Student Mechanical Engineering,
Massachusetts Institute of Technology, Boston

Missouri
BENJAMIN R., Sales Engineer,
McQuay-Norris Mfg. Co., St. Louis

Nebraska
GEORGE, VINCENT C., Private Electric Wiring Business,
Seward

New Jersey
FLETCHER, ANDREW JR., with
The W. & A. Fletcher Co., Hoboken
SMITH, ALBERT K., Assistant Chief Draftsman,
Westinghouse Lamp Co., Bloomfield
WADE, ALFRED D., Efficiency Engineer,
Schwarzenbach-Huber Co., West Hoboken

New York
BASSETT, CHARLES K., Secretary,
Buffalo Meter Co., Buffalo
BASSETT, ROBERT S., Treasurer,
Buffalo Meter Co., Buffalo
CHURCH, F. O., Mechanical Engineer,
Hill & Ferguson, Cons. Engrs., New York
DRESSLER, L. RICHARD, Inspector,
American Arch Co., New York
HILL, MAXWELL H., Machine Designer and Draftsman,
Camera Works, Eastman Kodak Co., Rochester
KRAUSE, WILLIAM A., Laboratorian,
Navy Yard, Brooklyn
LIPTAY, JOHN M., Mechanical Engineer,
They Kny-Scheerer Corp., New York
MACNABB, CLIFTON E., Sales Engineer,
Worthington Pump & Machinery Corp., New York
MEYLER, ROBERT G., Instructor in Industrial Engineering,
Cornell University, Ithaca
MURPHY, EDWARD S., Draftsman,
Honolulu Iron Works Co., New York
SMITH, RAYMOND P., Student,
Otis Elevator Co., Yonkers
WARDROP, GEORGE D., Editor, Aerial Age Weekly,
Aerial Age Co. Inc., New York
WARNER, DOUGLAS K., Graduate Student,
Sheffield Scientific School, Yale University, Brooklyn

Ohio
JAYNES, LUTHER L., Chief Clerk,
Whitaker-Glessner Steel Co., Portsmouth

Pennsylvania
ADDLEMAN, CLARENCE L., Mechanical Draftsman,
H. Koppers Co., Pittsburgh
JARRETT, HILLARD W., Instructor, Mechanics & Materials of Construction, Pennsylvania State College, State College
KELLER, JOHN O., Instructor in Industrial Engineering,
Pennsylvania State College, State College
MALONEY, CHARLES A., Power Plant Efficiency Engineer,
United Gas Improvement Co., Philadelphia
WILLIAMS, GEORGE B., Designer for United Engineering & Foundry Co., Pittsburgh

Rhode Island
NAUMBURG, ROBERT E., Efficiency Engineer,
Revere Rubber Co., Providence

Texas
DORRANCE, GEORGE W., Mechanical Engineer,
The Texas Co., Port Arthur

Vermont
STUART, H. HOWLAND, Assistant to Factory Superintendent,
E. & F. Fairbanks & Co., St. Johnsbury

Wisconsin
JACKLIN, HAROLD M., Instructor in Engineering,
University of Wisconsin, Madison

Philippine Islands
FAYMONVILLE, PHILIP R., First Lieutenant,
Ordnance Department, U. S. Army, Manila

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

New York
TRABOLD, FRANK W., Works Manager,
J. H. Williams & Co., Brooklyn

PROMOTION FROM ASSOCIATE-MEMBER

Massachusetts
MURRAY, ARTHUR F., Mechanical Engineer,
N. E. Westinghouse Co., Springfield

Ohio
QUAYLE, LEROY A., Chief Mechanical Engineer,
Dept. of Public Utilities, Div. of Water, Cleveland

PROMOTION FROM JUNIOR

Connecticut
PLEASONTON, FRANK R., Chief Engineer,
The Remington Arms, U. M. C. Co. Inc., Bridgeport

Michigan
HINKLEY, CARL C., Works Manager and Chief Engineer,
Chalmers Motor Co., Detroit

New Jersey
GIELE, WALTER S., Mechanical Engineer,
Palmyra

New York
CHALMERS, JOHN B., Instructor Steam and Applied Mechanics,
Pratt Institute, Brooklyn
LYMAN, ELIHU R., Assistant Works Manager,
Dexter Folder Co., Pearl River
MERRILL, GEORGE H., Secretary,
Merrill Brothers, Maspeth

Pennsylvania
BAUHAN, ALEXANDER E., Station Superintendent,
Pennsylvania Water & Power Co., Holtwood

SUMMARY

New applications	151
Applications for change of grading:	
Promotion from Associate	1
Promotion from Associate-Member	2
Promotion from Junior	7
Total	161

NECROLOGY

ORVILLE G. BENNET

Orville G. Bennet was born in New York City on August 17, 1881. He received his early education in the Horace Mann School and was graduated from Cornell University in 1904.

His first position was with Westinghouse, Church, Kerr & Co. He left that firm to become associated with the Ingersoll-Rand Drill Company, where he remained till 1906, when he accepted a position with the American Trading Company, representing that company in Japan until 1909, chiefly in the sale and installation of mining machinery. Not wishing to become permanently identified with the Orient, he resigned in 1910 to accept a position with the Akonite Company, New York City. In 1911 he took over the management of the export business of the General Motors Company, later becoming president and general manager of the company. He resigned this position in 1916, and at the time of his death was organizing a company for the distribution of the output of the Nash Motors Company in the state of Texas.

He became a junior member of the Society in 1907. He died February 28, 1917.

EDWIN J. HADDOCK

Edwin J. Haddock was born in Mount Vernon, N. Y., June 13, 1868. He was educated in the schools of New York City. He obtained his early experience in the shops and drafting rooms in the vicinity of New York, completing this training with seven years spent under the immediate direction of Thomas A. Edison.

He held successively the positions of chief draftsman of the Robins Conveying Belt Company, New York City; chief engineer of the Jeffrey Manufacturing Company, Columbus, O., and chief draftsman of the Tennessee Coal, Iron and Railway Company, Birmingham, Ala. Later, he engaged in private practise in Milwaukee, Wis., building numerous stone-crushing plants in that region. At the time of his death he was chief engineer of the Edgewater Steel Company, Pittsburgh.

He became a member of the Society in 1906. He died April 11, 1917.

CLINTON A. HAMILTON

Clinton A. Hamilton was born on October 5, 1873, at East Orange, N. J. He was a graduate of the high school of East Orange. He served a three-years' apprenticeship in the E. P. Allis Company's shops at Milwaukee, and then went to Pittsburgh to take a position with the National Tube Company. When he severed his connection with this firm he entered into consulting engineering in New York City, under the firm name of McClave, Hamilton & Remmer. Later he became general sales manager for the International Steam Pump Company, with headquarters at Pittsburgh. In 1906 he accepted the position of vice-president and general manager of the Wisconsin Engine Company, Corliss, Wis., and remained with this company for about six years, resigning to accept the position of vice-president and general manager of the Lavine Steering Gear Company, Racine, Wis. In 1913 he became president and general manager of the Racine Manufacturing Company, and retained this position until 1916, when he formed a partnership with Mr. James Cram and took over the sales agency of the Allen Motor Car Company. He was connected with this company at the time of his death.

He became a member of the Society in 1908. He died on March 12, 1917.

JOHN SEDGWICK HYDE

John Sedgwick Hyde was born in Bath, Me., March 25, 1867. He was a graduate of the Massachusetts Institute of Technology, class of 1888. He was connected with the Bath Iron Works, Ltd., in the successive capacities of apprentice, draftsman, paymaster, assistant superintending engineer, superintendent, vice-president and general manager and since 1905 as president of that company. He was a director of the Maine Central Railroad.

Mr. Hyde was a member of the New York Engineers' Club, Society of Naval Architects and Marine Engineers, American Society of Naval Engineers, and the Institution of Naval Architects of Great Britain. He became an Associate of the Society in 1892. He died at St. Augustine, Fla., March 17, 1917.

BRUCE C. McALPINE

Bruce C. McAlpine was born on June 2, 1872, at Pierceton, Ind. He received his early education in the high schools of Peoria, Ill., and Charlotte, Mich. From the latter he entered the Michigan Agricultural College, and was graduated from the mechanical-engineering course in 1905.

He entered the employment of George D. Walcott & Son, builders of machine tools at Jackson, Mich., as draftsman, and later became successively chief draftsman and general manager. Owing to changes in the ownership of the Walcott firm, he moved to Detroit, where he was engaged in the design of special tool equipment. In May 1913 he became chief draftsman and mechanical engineer for the Frost Gear & Forge Co., of Jackson, Mich., which position he held at the time of his death.

He became a member of the Society in 1914. He died on December 27, 1916.

WILLIAM F. MATTES

William F. Mattes was born on September 29, 1849, in Scranton, Pa. When seventeen years of age he was made superintendent of a small mining railroad near Mount Hope, N. J., and he continued in the iron-mining industry in New Jersey, and later in Virginia, until 1882, when he was made chief engineer of the Lackawanna Iron & Steel Works, of Scranton. In 1888 he became general manager of the West Superior Iron and Steel Works, West Superior, Wis. He was director of the First National Bank, president of the Manufacturers, Shippers' and Jobbers' Association, and park commissioner, of that city.

In 1893 failing health compelled him to move to Colorado, where he was interested in mining enterprises for several years. Later he returned to Scranton and was made chief engineer of the Lackawanna & Wyoming Valley Railroad Co. while

the Laurel line was in the process of construction. When his brother, Charles C. Mattes, died, he succeeded him as general manager of the Lackawanna Iron & Coal Co.

He was a member of the American Institute of Mining Engineers, The Franklin Institute, and the New York chapter of the Sons of the Revolution. He became a life member of the Society in 1882. He died on February 3, 1917.

EDWARD J. MARTIN

Edward J. Martin was born at West Roxbury, Mass., September 7, 1882. He was educated in the public schools of Boston. He then served an apprenticeship as machinist. He was a graduate of the mechanical engineering course of the International Correspondence Schools, and also of the Emerson Institute of Efficiency. At the time of his death he was secretary and manager of the Connecticut Electric Manufacturing Company. He became an associate-member of the Society in 1915. He died on April 7, 1917.

LEWIS R. POMEROY

Lewis R. Pomeroy, well known as a consulting mechanical engineer, especially expert in matters relating to the construction, maintenance and efficiency of locomotives and the necessary shop equipment, died suddenly at his home in Orange, N. J., May 7.

Mr. Pomeroy was born at Port Byron, N. Y., February, 1857, and was graduated from the Irving Institute, Tarrytown, N. Y. He early entered the railroad field, where his work attracted considerable attention. From 1886 to 1890 he was a special representative of the Carnegie Steel Company, introducing basic boiler steel for locomotives and special forgings for railways. For nine years he was engaged in similar work with the Cambria Steel Company and the Latrobe Steel Company jointly. He then became connected with the Schenectady Locomotive Works as assistant to the general manager, a position he held until 1902.

During the following six years he was a special representative for the General Electric Company in the railway field, this work covering the electrification of steam roads and railway shops and general application of electricity to all railway purposes. Subsequently, for two years, he was assistant to the president of the Safety Car Heating and Lighting Company, leaving to become chief engineer of the railway and industrial division of J. G. White and Company. Late in 1911, he resigned to open an office in New York City as a consulting engineer. In 1914 he became associated with the U. S. Light and Heat Company as manager of the New York office. For the past year or so he had again been engaged in consulting work along lines in which he was qualified by his wide experience.

Mr. Pomeroy was possessed of an enormous fund of information, and was ever ready to give unprejudiced help of a most dependable character. He was serious-minded, yet always cheerful; prompt in action yet painstaking and thorough; delightful in companionship, yet loyal to his convictions.

He joined the Society in 1890 and was Chairman of its Membership Committee at the time of his death. He was also a member of the American Institute of Electrical Engineers, the American Master Mechanics Association, the Railroad Club of New York, the Engineers' Club of New York, and the New York Railroad Club.

WILLIAM C. WILLIAMSON

William C. Williamson spent his early youth in Philadelphia, attending high school there. After leaving school he began his engineering experience by associating himself with a jeweler and watchmaker in repairing watches. This work was not especially to his liking and so he apprenticed himself to the old firm of Reaney, Neafie & Co., at that time one of the foremost engineering firms of the entire Atlantic seaboard.

In 1861 he entered the United States Navy as 3rd assistant-engineer, serving throughout the war. He resigned June 10, 1866, to engage in the engineering business with his two brothers, founding the firm of Williamson Brothers. His engineering talents soon showed in the Williamson type of clutch and frictional-geared cargo hoists. In the early eighties he introduced in a ship building at the yard of the William Cramp and Sons Ship and Engine Building Company, for the Metropolitan Steamship Company of New York, a steam engine to supersede the old type of hand steering wheel for the control of ships. It was an immediate success and entitles him to be classed among the foremost naval engineers of his day.

He was prominent also in financial affairs, being one of the oldest directors of the Kensington National Bank, and director and vice-president of the Industrial Trust, Title and Savings Company of Philadelphia.

He was a member of the Naval Order of the United States, Post No. 2, G. A. R., and the Engineers' Club of Philadelphia. He was a member of the Society of long standing, having been elected to membership in 1882. He died December 2, 1916.

The present inability of farmers to raise more grain is due to the lack of sufficient farm power and the scarcity of farm labor. For farm power farmers are dependent upon either animal power (horses and mules) or tractors. But the animal power will necessarily decrease, owing to the demand of the army for horses and mules. Hence the necessity for the intelligent use of farm tractors on a large scale.

Statistics collected by the Bureau of Farm Management of the Department of Agriculture show that there are now available in the United States approximately 35,000 tractors.

The limiting factors in the production of tractors are today the shortage of materials, machine tools and labor. The Government has been asked by the Tractor Standards Division of the S.A.E. to devise means whereby the tractor manufacturers can be furnished with the materials, machine tools and labor in suitable quantities.

Tentative plans for an organization to be known as the National Committee of Industrial Safety, to act as an auxiliary to the advisory commission of the Council of National Defense, were drawn up at a meeting under the auspices of the American Museum of Safety in New York, Tuesday, April 24. The committee is to have 15 members, selected because of activities in fire protection, structural safety, dust and fume control, etc. Among those already named are: Colonel T. L. Bryant, Arthur H. Young, Lew R. Parmer, C. L. Close, Dan H. Manning, M. A. Dow, Robert B. Kohn, J. L. Mauran, Owen Brainard, Elmer Jensen, and D. Everett Waid. Headquarters will be in the Octagon Building, Washington. (*Daily Iron Trade and Metal Market Report*, vol. 7, no. 82, April 26, 1917, p. 4)

AMONG THE SECTIONS

THE Entertainment Committee of the New York Section made very complete arrangements for the Annual Social Evening which was held in the large dining hall of the Machinery Club, New York City. The speakers of the evening were Edwin J. Prindle, Toastmaster; President Ira N. Hollis, Commander E. P. Jessop, and John J. Swan. All of the speeches related to the part of the engineer in the enormous task confronting the country in the war. These are busy times and a large percentage of the New York membership were evidently unable to attend; nevertheless those present were well rewarded as the occasion was a most enjoyable one. The Entertainment and Acquaintanceship Committees of the New York Section have been doing excellent work in providing opportunity for more of the "human element," and the committees are to be congratulated upon their latest success.

THE FIRST SECTION IN CANADA

The first Section of the Society outside of the domain of the United States was established recently at Toronto, Canada. The Council at its April meeting approved the petition of the members of the Society in the Province of Ontario for permission to hold meetings.

The Executive Committee of the Ontario Section, as it will be known, is: G. V. Ahara, Prof. R. W. Angus, C. R. Burt, L. H. Fletemeyer and C. B. Hamilton.

A CONNECTICUT STATE SECTION

A meeting was held at Bridgeport on May 2, at which were present members from most of the prominent cities of the State of Connecticut. The object was to consider the advisability of forming a State Section, with branches at several centers. The existing New Haven Section was represented by Messrs. Henry B. Sargent, Chairman, Joseph W. Roe, and J. A. Noreross. It was agreed to formulate a plan whereby a Connecticut State Section will be organized, with headquarters probably at New Haven, where at least two meetings will be held annually, as at present, and in addition it is planned to hold each year at least one meeting at each of the following centers: Bridgeport, Hartford, Meriden and Waterbury. A committee was appointed to arrange the necessary details for putting the idea into effect, consisting of Messrs. Henry B. Sargent, Chairman, C. K. Decherd, H. E. Harris, S. F. Jeter and E. S. Sanderson.

A quorum of the Committee on Sections was present at the meeting, D. Robert Yarnall, Chairman, L. C. Marburg and Walter Rautenstrauch. Secretary Rice acted as chairman of the evening, and an address was made by Judge Edward K. Nicholson on ways in which engineers can coöperate in the mobilization of the resources, industrial and agricultural, of the United States.

The meeting approved a motion to petition the Council to take a referendum vote of the members of the Society to determine whether we should support national prohibition during the period of the War as a means toward greater industrial effectiveness and a saving in spoiled material.

BALTIMORE

April 12. At the meeting of the Section held at the Engineers' Club the following officers were elected for the ensuing year: Chairman, W. W. Varney; vice-chairman, A. B. Robertson; secretary, A. G. Christie; and treasurer, C. C. Thomas. William Chatard was elected a member of the Executive Committee.

Alten T. Miller, Vice-President of the Bartlett Hayward Co., of Baltimore, gave a most interesting address on Munitions and Preparedness, and the discussion of the subject which followed was of much interest and proved most instructive to all present.

A. KENNEDY,
Temporary Branch Secretary.

BUFFALO

April 18. A History of Aviation was the subject of the paper delivered before the Engineering Society of Buffalo by Charles M. Manly, Mem.Am.Soc.M.E. Mr. Manley, who has been actively engaged in aeronautics for many years, was associated with Professor Langley when the latter developed his ideas of the physics of the air and the art of flying. His paper treated particularly of the early development of aviation and included the present military problems being met in flying.

The following resolution was adopted at this meeting:

"Resolved, that the Engineering Society of Buffalo express its approval of the principle of universal and obligatory military training and service, and that we urge the Senators and Representatives in Congress of the State of New York, and particularly the Representatives of the Buffalo districts, to support in every way possible this principle, especially as it is embodied in the Administration measures looking to the raising of an army on this basis."

May 2. At the annual meeting John Younger, Mem.Am.Soc.M.E., resigned from the office of president, which he has held for three years, during which time the society has become known as one of the most energetic and useful engineering bodies. The election resulted in the choice of the following officers for the coming year: President, F. A. Lidbury, Mem.Am.Soc.M.E.; first vice-president, D. W. Sowers, Mem.Am.Soc.M.E.; secretary, F. B. Hubbard, Mem.Am.Soc.M.E.; treasurer, W. M. Dollar, Mem.Am.Soc.M.E.; directors, H. B. Alverson, Mem.Am.Soc.M.E., and F. E. Cardullo, Mem.Am.Soc.M.E.

LOUIS J. FOLEY,
Assistant to Secretary.

DETROIT

April 20. A number of the members and several ladies attended the dinner on this date, which was followed by an address by John W. Lieb, Mem.Am.Soc.M.E., on Leonardo da Vinci—Artist, Philosopher and Engineer. Mr. Lieb's address was most interesting, as it was based upon his researches during a residence of ten years in Italy, in the early days of electric railroading.

J. W. PARKER,
Section Secretary.

MERIDEN

May 3. An illustrated lecture on the Steam Turbine was given by J. Breslav, Mem.Am.Soc.M.E., before the Meriden members of the Society. This lecture proved of much interest and general discussion by those present followed.

R. S. BROTHERHOOD,
Secretary.

NEW YORK

May 8. Mr. Siegfried Rosenzweig, Mem.Am.Soc.M.E., addressed the meeting on The Development of the Poppet Valve Steam Engine with Special Reference to its Present Status in the United States.

Under the heading of thermal considerations, the author enumerated the advantages of high steam pressures and high superheats, and gave reasons why under such working conditions the poppet-valve engine is the most suitable type. He showed how

and why the application of high steam pressures and superheats and the development of the poppet-valve engine eliminate the multiple-cylinder arrangement, leading to compound engines and finally to single-cylinder engines, particularly of the uniflow type. The advantages and disadvantages of each type were defined and explained. Comparative steam consumptions of Corliss, poppet-valve and uniflow poppet-valve engines were given, and also the economies of small and medium-size turbines and uniflow engines were compared.

This part of the paper was followed by a consideration of structural features, in which the stationary engine, the locomobile, the marine engine, and the locomotive were described in a general way, and in a number of designs the development of these important types explained. The paper concluded with an explanation of a number of the different and most prominent types of valve gears and detail constructions, the latter with special reference to the best forms of cylinder designs. Both American and European types were shown.

The lecture was fully illustrated by lantern slides and drew forth considerable discussion.

A. D. BLAKE,
Section Secretary.

PHILADELPHIA

April 24. D. Robert Yarnall, Mem.Am.Soc.M.E., the speaker at this meeting, presented a paper on Recent Developments in V-Notch Weir Measurement.

The paper was fully illustrated with lantern slides and the speaker traced the early history of the V-notch weir, showing the various steps in its evolution up to the present time. Particular emphasis was put on the fact that the V-notch weir, irrespective of the particular make of the instrument, furnishes the most successful method of measuring liquids.

The results of the tests at the University of Pennsylvania, in which a Lea instrument was used, were given. Here the accuracy curve for various rates of flow was practically a straight line. The water used in the test was weighed by very accurate scales and the percentage of error during the entire test was about 0.6 per cent., while the guaranteed accuracy of most instruments of this type is about 1.5 per cent. A discussion followed in which J. W. LeDoux, Mem.Am.Soc.M.E.; T. C. McBride, Mem.Am.Soc. M.E., and L. F. Moody, Mem.Am.Soc.M.E., participated.

May 22. The closing meeting of the season was held on this date, and in order to continue the helpful spirit of coöperation now prevailing in Philadelphia, Mr. Willard Beahan, First Assistant Engineer, Lake Shore and Michigan Southern Railway, addressed this Section on Engineering of Men.

All the Members of the Engineers' Club of Philadelphia and all the engineering organizations affiliated with the club were invited to hear Mr. Beahan, and the response was general.

In order to further promote harmony and to tie the various organizations together more closely, a dinner was given to the chairmen of the several affiliated societies, the president of the Engineers' Club, and the president and secretary of The Franklin Institute.

W. R. JONES,
Secretary.

PROVIDENCE

May 2. The second annual banquet of the Providence Engineering Society, held in Elks Hall, surged with patriotic enthusiasm as the representatives of four of the allied countries addressed the audience.

Mayor Gainer, the first speaker of the evening, welcomed the distinguished guests and declared that the United States was in the war to stick until victory was assured.

Capt. M. de Jarny, a French military officer sent here after many months' service in the trenches to instruct the Harvard Training Camp, acted as the representative of Ambassador Jusserand. He said that the war is an engineers' war and that the United States, the greatest engineering country in the world, is sure to play a great part in it for that reason.

Capt. Nathan Horowitz, U.S.A., declared that the word "engineer" was a synonym for efficiency, and that efficiency must guide every action taken by the citizens here so that all the resources may be used to the best advantage. His brief talk closed with a reassurance that the coast defences of the country were sufficient as our harbors are amply protected by nets. He also said that we were not awake to the reality of war and that the sight of a submarine or Zeppelin might arouse us more fully to a realization of our duty.

M. S. Davidson, of Toronto, prefaced his talk with "Comrades-in-arms," which was greeted with applause. He said that the Allies had been confident of winning with or without the United States, but that he thought the war should be considerably shortened by the entrance of this country into the combat. The speaker said that the greatest good derived from the war was the new conception of life which all of the fighting countries are gaining.

Dr. Ira N. Hollis, Pres.Am.Soc.M.E., spoke on behalf of the United States. Dr. Hollis said: "Many young men have asked me in the last few weeks how they could do their share. Our country must provide a man for every place and we must have an agency of the Government to allot the men to the places where they can best serve. We serve best in this funeral procession on the way to the burial of the divine right of kings, when we fit into the place where we can do the most good."

Prof. Albert Van Hecke, of the University of Louvain, was Belgium's representative. He told of the sufferings that Belgium has undergone since the outbreak of the war and something of the atrocities, and followed with motion pictures of scenes in the refugee camps in Holland. These pictures gave views in the different workshops, homes, schools and playgrounds, and showed how the work has been systematized by Professor Van Hecke.

ALBERT THORNLEY,
Corresponding Secretary.

ST. LOUIS

April 11. H. R. Setz, Mem.Am.Soc.M.E., read a most interesting paper on Some Unusual Applications of the Diesel Engine, before the joint meeting of the Section and the Engineers' Club.

The paper dealt with the application of the Diesel engine to traction problems on railroads. The greatly varying relations between train speeds on level and rising or falling tracks, engine hp., point of cut-off and tractive effort were first explained by means of a typical dynamometer test chart from a steam locomotive.

Gasolene engines have for some time been used for traction service and, as far as the technical solution of the problem is concerned, have been an entire success. Mr. Setz explained why Diesel engines, owing to their greater flexibility, lend themselves even more readily to this class of work.

He then gave particulars of three methods by which the Diesel engine can be made use of for traction purposes, as follows:

Direct drive, in principle similar to the present practice with steam locomotives. Since at the slower speeds the Diesel engine would be unable to produce the necessary tractive effort, provisions must be made to increase artificially the mean effective pressure in the engine cylinder beyond that resulting from the regular cycle of operation. This is accomplished, while running, by the admission of extra charges of fuel oil together with high-pressure air, while for starting, the range cut-off of the starting valve must be extended to about 70 per cent of the piston stroke.

Mechanical drive, obtained by speed-change gears similar to present practice in automobile construction. For the purpose of smooth operation it is important that the engine hp. as well as the momentary tractive effort resulting from a change of speed be the same both before and after shifting the gear. Particular attention is to be paid to a suitable form of clutch. As modifications of the mechanical drive should be mentioned the various methods of hydraulic and compressed-air transmissions, which are primarily to increase the torque in starting and at slow speeds.

Electric drive, consisting of a regular Diesel-electric generating unit located independently on the car or locomotive without regard to the driving axles, which latter are driven by a suitable number of motors through gears. Here the torque may be varied either by varying the voltage or the speed of the engine.

Mr. Setz explained by means of diagrams and lantern slides the theoretical considerations underlying the different forms of Diesel engine propulsion.

A lively and extended discussion followed, showing that the subject was both interesting and timely.

L. A. DAY,
Section Secretary.

STUDENT BRANCHES

Members of Student Branches are requested to notify the Secretary of any change in address as promptly as possible, in order to facilitate delivery of The Journal.

The Society has received from the Student Branches accounts of the measures taken by the student bodies regarding preparedness for national defense. That each university and college is "doing its bit" in this respect is shown by the summarized reports below.

Armour Institute of Technology. Entire student body meeting once a week for drill; military training compulsory. One hundred undergraduates to enlist in Navy. Plans in formation for instruction to be given in internal-combustion engineering for men training for service in United States Coast Defense Patrol.

Bucknell University. Student branch offered services to War Department, with request as to how to be of greatest service.

University of California. Cadet corps numbers 1263; 35 immediately available for commissions and 300 within the year. One of the universities designated by the War Department as training school for aviators; school to start shortly.

Case School of Applied Science. All students taking military drill each day. Work to be increased toward end of term. Application now in for Government to establish senior unit of the Officers' Reserve Corps in this institution. Two instructors received commissions in Officers' Reserve Corps.

University of Cincinnati. Military problems being introduced in all courses in civil, chemical, electrical, and mechanical engineering.

University of Colorado. Engineers corps of 50 men formed. Company of cavalry organized; to be increased to full squadron shortly.

Colorado State Agricultural College. Nearly half student body applying for membership in Officers' Reserve Corps; some have received commissions. Military instruction given daily to undergraduates.

Columbia University. Aerial Coast Patrol Unit No. 4 in formation. Six-week courses in military and naval subjects started, to include trench warfare, map reading, radio telegraphy, mining, trench signal service, infantry drill, military law, practical navigation, electric steering, turret control, gyroscopic compass, submarine signals, etc. Ambulance unit plans in formation. Signal corps in training. Agricultural volunteer system inaugurated, with credit given to students volunteering. Military census being taken.

Cornell University. Cadet corps numbers 2000; training in charge of regular United States officers; equipment up-to-date and complete; corps comprised of regiment of infantry, engineering division, machine gun division, signal corps, ambulance division, and military band; officers of corps are students holding commissions. Six hundred students enlisted in Government service; majority in mosquito fleet at Newport. Cornell ambulance unit for service in France enrolled and equipped and now in service; second unit to leave in a few weeks. Plans for new field battalion of signal corps in formation. Complete military census of undergraduate body taken. One of the universities designated by the War Department as training school for aviators; school to start shortly.

Georgia School of Technology. School offered to Government as military training center for officers. Aviation school in formation. Government expected to take advantage of offer shortly.

University of Illinois. Usual military training being pushed to the limit. Student aviation corps in formation, with many applications for membership. One of the universities designated by War Department as training school for aviators; school to start shortly.

Johns Hopkins University. Reserve Officers' Training Corps organized at beginning of collegiate year; battalion of 250 men drill under officer from War Department. Five men have commissions in the Reserve Corps and thirty have enlisted in the naval reserve and state militia. Credit for balance of year given to all enlisting.

University of Kansas. Courses in military science and engineering organized under direction of Dean of Engineering. Many undergraduates applying for admission to Officers' Reserve Corps and to the Quartermaster's Department. Credit for the balance of school year being given students enlisting or taking industrial positions in the service of the country.

Leland Stanford Junior University. Credit being given students entering intensive military training or active service. About 800 students now in training. Large number of advanced engineering students excused to take up industrial work in connection with federal contracts. Officers' Reserve Corps has many applications for admission. A few students taking up aviation. Two complete ambulance corps now in France.

Lehigh University. Class in military training held four times a week. Chemists have list of men classified for industrial positions.

University of Maine. Two years' military training required of all students; courses rearranged to permit of entire student body taking military training two hours daily. Courses in map making and reading, problems of intrenchment, use of high explosives, and signal corps work established and well attended. Many students enlisting in Coast Patrol. Cadet battalion of 332 men.

Massachusetts Institute of Technology. Trains all constructors for Navy. All seniors graduated in advance and now in service. Military department, existing for fifty years, now being enlarged. Engineering courses being reorganized on war basis to train men for technical departments of the army, engineering division, coast artillery, signal corps, and ordnance. Laboratories placed at disposal of Government. One of the universities designated by War Department as training school for aviators; school to start shortly. Industrial survey of alumni, started last year, now being completed.

University of Michigan. Seven companies of engineers organized; drilling twice a week. Special courses being given in military engineering, camp sanitation, transportation of supplies and munitions, high explosives, etc. Many students leaving to join various military and naval units.

University of Missouri. Special company of fifty cadets now in intensive training; eight immediately available for commissions, and thirty more within the year.

University of Minnesota. Military corps numbers 1250; 50 immediately available for commissions; 300 to attend officers' training camp this summer. Resolutions passed by students pledging themselves ready and willing for active service.

University of Nebraska. Cadet corps numbers 800 men; 46 immediately available for commissions and 100 within the year.

New York University. Red Cross ambulance company of 100 men formed; drill three hours a week under regular army officer. Four companies of Reserve Officers' Training Corps formed, seventy men to a company, receiving three hours' drill a week. Courses in ordnance and gunnery, electrical and steam engineering, signaling, and navigation on board battle ship *New Jersey* discontinued. Course in signaling to be given in university.

Ohio State University. About one thousand students leaving either for Officers' Reserve Corps, industrial positions, or agricultural pursuits; full credit being given these students. Sophomore regiment of cadets have open-order drill on Saturdays, besides regular drill periods. One of the universities designated by War Department as training school for aviators; school to start shortly.

University of Oklahoma. Compulsory military drill established throughout university. Engineering school forming signal corps for two upper classes. Sixty-four students to enter officers' training camp at Fort Logan H. Root, Arkansas. Intercollegiate Intelligence Bureau making complete investigation of alumni and undergraduates as to fitness for Government service.

Oregon Agricultural College. About fifty per cent of the seniors and twenty per cent of the junior engineering students qualified for Reserve Officers' Training camp at San Francisco. Full university credit being given these students. Many undergraduates leaving to take up work on farms.

Pennsylvania State College. Cadet corps numbers 1500; 300 men available for commissions and 300 more within the year. Courses being given in aeronautics, navigation, ordnance, and quartermaster work. Special instruction in ambulance and first-aid medical field service.

University of Pittsburgh. Survey of all students and alumni prepared and forwarded to National Intelligence Bureau. University wireless plant now at the service of the Government. Base hospital formed in school of medicine. Lectures given on camp sanitation. Regiment of six companies has 700 students enrolled; daily drill. Agricultural bureau of the university enlisting students for farm work. Full credit being given to those enlisting and to those taking up agricultural or industrial work.

Polytechnic Institute of Brooklyn. Training corps of 160 established; drills three hours a week at 13th Regiment armory. About twenty students in Naval Reserve and about 12 per cent. of the student body in active service.

Purdue University. Cadet corps numbers 1000; 300 to attend officers' training camp and will be available for commissions; 300 more within the year.

Rensselaer Polytechnic Institute. Course in military engineering established. Military instruction to be instituted immediately. Over one hundred undergraduates leaving for Officers' Reserve Corps, Naval Engineering Corps, regular army, or state militia.

Stevens Institute of Technology. All students being drilled five times a week. Commencement advanced to permit of students entering camps.

Syracuse University. Eight hundred students drilling twice a week; 150 graduate students to enter Officers' Reserve Corps. Ambulance corps being formed. Credit being given students enlisting or entering agricultural or industrial work.

Virginia Polytechnic Institute. Course of lectures by Red Cross representative attended by student body. Four hours of military drill daily. About one hundred students certified for admission to Fort Myer officers' training camp. Cadet corps a unit of Reserve Officers' Training Corps.

Washington University. Plans are now being made to form Reserve Officers' Training Corps, modeled after Yale's, to be under authority of War Department. About one hundred men already in national service and about one hundred more to be enrolled in reserve officers' training camps. Many students to go as ambulance drivers to France.

University of Washington. Cadet corps numbers 800; 100 available for commissions within the year; 85 to attend officers' training camp at San Francisco. Complete census of undergraduates and alumni taken.

University of Wisconsin. Courses offered in intensive military training with full credit allowed. Cadet corps numbers 1200; 140 available immediately for commissions and 600 within the year.

Worcester Polytechnic Institute. Military training of students under experienced drill officer. Number of seniors to take forthcoming examinations for commissions in regular army; such students excused from all regular institute work. Work of engineer officers outlined in address by Captain Williford, of Coast Artillery

Yale University. About 1500 men engaged in military work; 300 immediately available for commissions and 600 within the year. Regular army officers in command of the men. Aerial coast patrol unit formed and in training. Naval training unit enrolled. Hospital unit organized and ready for service abroad. Signal corps unit in active training. Many students already in active service abroad. Laboratories offered to Government. Intercollegiate Intelligence Bureau work being forwarded.

Preparedness in its different phases is not confined to any group of universities or colleges, but throughout the country there is a general movement among college men to make themselves ready for the call.

Brown University. Military unit of 250 in training; 150 men organized for agricultural work. University equipped several ambulances for use in France. Many undergraduates to go to Plattsburg.

Colgate University. Military drill being instituted for all students under Plattsburg men. Full credit being given to all students enlisting or taking up agricultural or industrial work. Laboratories and other facilities of the university offered to Government. Special military courses being given.

Dartmouth College. Five hundred withdrawn to enter Naval Reserve, Reserve Officers' Training Corps, and Aviation Corps. Two complete ambulance units equipped and on the way to France. One thousand drilling daily. Military census being taken. Vacant land being intensively cultivated.

Delaware College. Ambulance corps organized and equipped. Military census of undergraduates and alumni taken. Many students leaving to enlist in active service.

Fordham University. Military training compulsory. Over 1000 students drilling daily, about 100 applying for admission to Plattsburg. Ambulance Corps No. 6 in formation.

George Washington University. First Company, Coast Artillery, District of Columbia Guard, formed in 1915, in active District service. Many students to enter Fort Myer Officers' Reserve camp. Military census taken.

Harvard University. Officers' Training Corps numbers 1200 men, under regular army command. Five French army officers assisting in training. Ambulance unit now in service in France.

University of Indiana. Training corps numbers 342; 50 per cent. of this number to be available within the year for commissions.

Massachusetts Agricultural College. Cadet corps numbers 426; 47 are available for commissions and have enrolled in the Government officers' training camps.

Michigan Agricultural College. Cadet corps numbers 875; 150 men are immediately available for commissions; 250 within the year.

New Hampshire College. Cadet corps numbers 380; 12 immediately available for commissions and 75 more within the year.

New Mexico School of Agriculture and Mechanic Arts. Intercollegiate Intelligence Bureau taking census of alumni and students. Agricultural school in full charge of agricultural resources of the state for greater crop returns. Practically all of engineering students applying for admission to Officers' Reserve Corps.

College of the City of New York. Complete equipment of chemistry building and services of faculty offered to Government. Resolutions adopted expressing students' willingness for national service. Ambulance unit plans in formation.

North Carolina College of Agriculture and Mechanic Arts. Cadet corps numbers 400; 60 available for commissions, 60 more within the year.

Norwich University. Cadet corps numbers 200. Ten seniors designated for regular army commissions and four as second lieutenants in the Marine Corps.

University of Notre Dame. Cadet battalion in training; 90 immediately available for commissions and at least one-fourth of the whole battalion within the year.

Pennsylvania College. Cadet corps numbers 314; 35 immediately available for commissions and 120 within the year. Many students to attend officers' training camps this summer.

University of Pennsylvania. Twenty-two hundred students drilling daily under regular United States officers. University Base Hospital No. 20 ready to sail for France. Over two hundred students enrolled in army of commissary for work on farms. Military census just completed.

Princeton University. Military drill established. Aviation school started, with more than two hundred applying for admission. About two hundred to enter officers' reserve training camps. Four ambulance units of twenty-five men each to sail for France the end of May for field service with the American Ambulance Corps. Full credit allowed those enlisting.

Rhode Island State College. Cadet corps numbers 252; 15 immediately available for commissions and 50 more within the year.

Rose Polytechnic Institute. Military training started. Plans being worked out in connection with National Defense Council and National Research Council. Laboratories well equipped for preparedness work.

Rutgers College. Reserve Officers' Training Corps numbers 300; 37 immediately available for commissions. Students being released for farm work. Plans in formation for students not in direct military service to enter munitions making.

Trinity College. Unit of Officers' Reserve Corps established. Half of undergraduate body drilling ten hours a week. Courses established in military science. Twenty-five men enrolled in Connecticut National Guard and others in ambulance and machine-gun divisions.

Tufts College. Military census taken of students and graduates. About fifty enrolled in Naval and Coast Defense Reserves. Division of ambulance field service now being organized. Twenty students accepted for Officers' Reserve Corps. Credit being given to those enlisting or taking up agricultural or industrial work.

Tulane University of Louisiana. All facilities of laboratories offered to Government. Questionnaire sent to 3300 alumni to determine number willing to enlist. Many graduates of Medical Department enlisted in service. Large number of engineering alumni in officers' training camps.

Union College. Two hundred and twenty-five students drilling four hours a week; non-commissioned officers' class for seventy-five. Courses of lectures, with field work, given on military engineering, code and flag signaling, and military topography. Military census taken.

University of Vermont. Student cadet corps of 250 men; 80 available for commissions within the year. University sent a complete infantry company and medical detachment to Mexican border last summer.

Williams College. Training corps consisting of 420 men; 200 available for Federal service within the year; 20 seniors to go to Plattsburg.

ARMOUR INSTITUTE OF TECHNOLOGY

April 24. Robert Randolph was the speaker at the joint meeting of all the engineering societies, speaking on the Potential Resources of the Drainage Canal in Time of War. After the lecture which was illustrated with lantern slides, Mr. Randolph answered many questions concerning military matters and his explanations were most enlightening.

May 7. A business meeting was held at which the following officers were elected: W. H. Bretting, president; K. A. Taylor, vice-president; V. A. Kerr, secretary; N. L. Marvin, treasurer. The newly elected officers gave short talks following their appointment.

ABE J. PLOCINSKY,
Branch Secretary.

BUCKNELL UNIVERSITY

May 7. C. C. Kepple gave an interesting and instructive talk on the Field and Future of the Low-Pressure Steam Turbine. The most important point in the discussion was the showing of the increased efficiency of a plant due to the installation of a low-pressure turbine. Prof. F. E. Burpee, Mem.Am.Soc.M.E., gave a short discussion on the same subject.

C. M. KRINER,
Branch Secretary.

UNIVERSITY OF COLORADO

April 26. Organization was the subject of an address before the Branch by Prof. John A. Hunter, Mem.Am.Soc.M.E. Later the annual election of officers took place, resulting as follows: President, H. T. Sears; vice-president, R. B. Burlingame; secretary, H. O. Croft. The election was followed by a big get-together.

H. O. CROFT,
Branch Secretary.

UNIVERSITY OF ILLINOIS

April 19. In competition for prizes offered the Junior and Sophomore classes by Pi Tau Sigma, Mr. Shonkwiler delivered a short talk on Ice Plants and Refrigeration, and was followed by Mr. Morse, who spoke on Speed-boats and Hydroplanes. Both talks were interesting and well illustrated with lantern slides.

H. C. DIESERUD,
Branch Secretary.

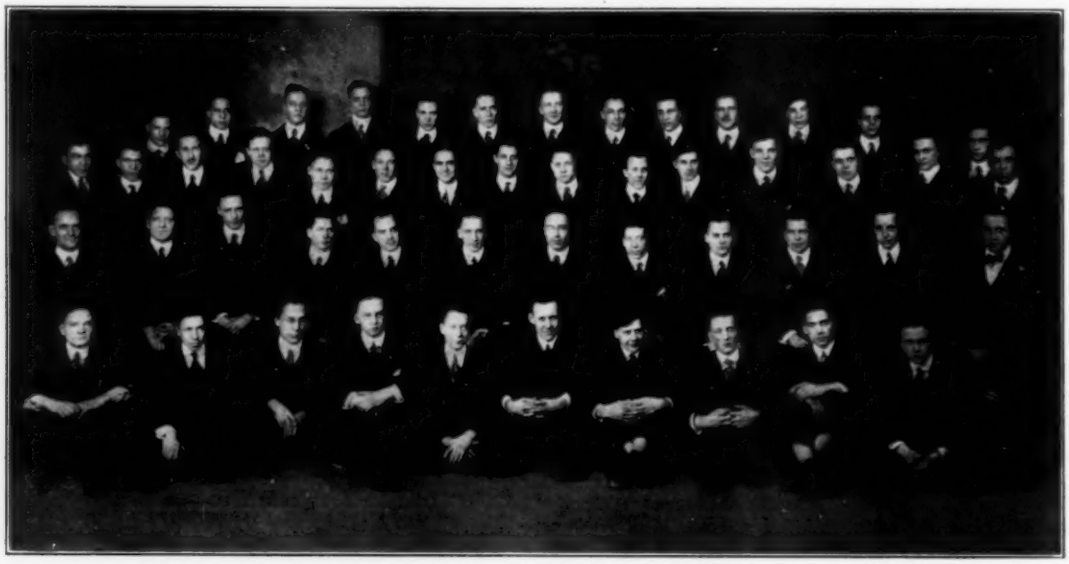
KANSAS STATE AGRICULTURAL COLLEGE

May 1-4. Engineers' week was celebrated by the students starting with open house and a band concert, moving pictures showing many manufacturing processes and engineering works.

At the regular Branch meeting Joseph Harrington, Mem.Am. Soc.M.E., gave an interesting talk on boiler settings and furnace combustion.

A parade was held with many interesting and attractive floats, one of which was a small gas tractor, built complete in the college shops and consisting of a 1½-hp. gas engine mounted on specially built trucks, which gave a small but powerful tractor. There were many novel features among the floats, such as one which carried the power plant which furnished power and light for the other floats, another with a small mill in operation, one showing an electrical "wash day" as compared with the old-style kitchen, and many others of equal interest. The closing event of the week was the annual engineers' ball.

WILLIAM N. CATON,
Branch Secretary.



UNIVERSITY OF CINCINNATI STUDENT BRANCH AM.SOC.M.E.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

May 3. The close of a very successful year was celebrated by the Annual Banquet, at which the principal speakers were Ira N. Hollis, Pres., Am.Soc.M.E., Rowland W. Boyden, and Prof. E. F. Miller, Mem.Am.Soc.M.E.

Professor Miller sounded a warning to the men going out from the Institute into the Government's service in the capacity of munition inspectors, as they are open to many temptations in the way of graft.

Mr. Boyden said that it was now time for us to consider facts sanely and with calm judgment, as we receive proofs every day of the stupendousness of the task confronting us. Those in high authority in the Army and Navy must now have broad vision and administrative and executive powers in order to make an impression on the enemy, and we can congratulate ourselves on the number of men we have who possess these powers. The so-called "captains of industry" are just the men of this type who will produce efficiency, and Mr. Boyden cited several examples of both young and older men who are proving their patriotic spirit and devotion to their work.

Dr. Hollis advised the men to read history to see what the

end of the war is destined to be. He considered the definition of civilization as given by Louis Pasteur the best—"That civilization in which the individual is permitted to develop himself to the maximum capacity for the benefit of mankind." As the blood was to many of us the symbol of the washing away of the sins of the world, now bloodshed may again be worthy to fulfill the command, "Love thy neighbor as thyself." The development of the engineer, Dr. Hollis said, has gone hand in hand with democracy, and there is a tendency of science to weld the nations together. The mechanical engineer has a peculiar right to claim that his share in this war is preëminent, and each individual should prepare himself for whatever he is best fitted.

Announcement was made of the result of the election of officers for the coming year, as follows: Chairman, A. Saunders, vice-chairman, A. L. Hamilton, treasurer, H. W. Fitch, secretary, S. H. Caldwell.

S. H. CALDWELL,
Branch Secretary.

OHIO STATE UNIVERSITY

April 25. Mr. Fikret, instructor in the mechanical-engineering department, gave a well-illustrated lecture on the construction and equipment of the Essex Power Station of the Public Service Electric Company of New Jersey, with which company he was formerly connected.

F. E. SYMSER,
Branch Secretary.

OREGON STATE AGRICU . . RAL COLLEGE

April 19. A general business meeting was held and officers for next year nominated.

May 10. After the regular routine of business the following officers were elected for next year: President, A. O. Leech; vice-president, F. P. Myers; secretary, H. W. Fish; treasurer, H. B. Morris.

ARCHER O. LEECH,
Branch Secretary.

OKLAHOMA UNIVERSITY

May 8. E. W. Pembleton addressed a joint meeting of the electrical and mechanical branches on Gasolene Extraction from Gas, and was followed by Prof. L. W. W. Morrow, who spoke on illumination.

The latter paper was illustrated by lantern slides and discussed the mechanical operation of the eye, the limited number of light waves which can be seen, and the causes and results of eye strain. The methods of avoiding them by proper illumination were also explained.

TOM L. SOREY,
Branch Secretary.

POLYTECHNIC INSTITUTE OF BROOKLYN

May 5. Samuel P. Blakeman, Mem.Am.Soc.M.E., gave a most interesting talk on S.K.F. Ball Bearings.

Mr. Blakeman described in detail the manufacture and various uses of the ball bearings and illustrated his points with many interesting lantern slides.

The following officers were elected for the coming year: President, Frederick H. Bromm; vice-president, Charles L. Schweizer; treasurer, Joseph L. Kopf; secretary, Nathan N. Wolpert.

GEORGE CHERR,
Corresponding Secretary.

SYRACUSE UNIVERSITY

May 7. After a few general remarks addressed by the President to the new members of the Branch concerning its principles and aims, short talks were given by Messrs. M. P. Whitney, M. P. Ferguson, Smith, and Lanigan. W. I. Rodgers, Jr., followed with a report of the Joint Student Branch Conference in New York.

The officers for next year were elected as follows: President, Maurice P. Whitney; vice-president, Walter I. Rodgers, Jr.; secretary, T. Dean Howland; treasurer, Malcolm P. Ferguson.

T. DEAN HOWLAND,
Branch Secretary.

VIRGINIA POLYTECHNIC INSTITUTE

May 1. City Management was the subject of a most interesting and informing paper presented by R. S. Royer, City Manager of Fredericksburg, Va. This is a new field of work for engineers and the paper was received with much interest by the members of the branch.

G. F. MINOR,
Branch Secretary.

UNIVERSITY OF WISCONSIN

May 3. Prof. W. J. Mead of the Geology Department gave an interesting illustrated lecture on Landslides at this meeting.

JOHN M. WOOD
Branch Secretary.

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping anyone desiring engineering services. The Society acts only as a clearing house in these matters.

POSITIONS AVAILABLE

In forwarding applications, stamps should be enclosed for transmittal to advertisers; applications from non-members should be accompanied by a letter of reference or introduction from a member, such reference letter to be filed with the Society. Copy for notices must be in hand by the 15th of the month.

INSTRUCTORS for school of mechanical trades in Iowa. Salaries $1,000 to $1,200. Promotion dependent to large extent upon commercial work which can be turned out during year. Men wanted now are as follows:

(*a*) Energetic young man with some business ability to take charge of automobile department doing large repair business; must know subject thoroughly and be able to build up department educationally and commercially. Competent to teach automobile lines, including electric-cranking, lighting and ignition course, to organize material and work in such way that maximum number of students can be handled with minimum teaching force and expense.

(*b*) Man to handle foundry and machine shop and possibly forge. 676.

TECHNICAL ENGINEER, with experience in steam engineering, to act as assistant operating engineer in large industrial plant located near Chicago. State age, experience and salary expected. 938.

YOUNG TECHNICAL GRADUATE with one or two years' experience in steam engineering, for testing work; location New Jersey. State age, experience and salary expected. 939.

MASTER MECHANIC for steel mill; experienced in this line of work and able to handle 60 to 75 men. Age 28 to 40, and a hustler. Salary about $2400. Location Pennsylvania. 1000.

DRAFTSMEN AND DESIGNERS. Experienced men with knowledge of valves and fittings; good future with large concern. State experience in full, salary expected and references. 1002.

ESTIMATOR, general jobbing and manufacturing shop; man ex-

perienced in general machine plate and structural work. State experience, salary desired and when available. Location New Jersey. 1006.

GENERAL CORRESPONDENT to be located in New York office of concern doing business with South American countries. Must speak Spanish. Prefer South American or one who has resided in South America and is familiar with conditions and language from personal experience. Salary depends on man. 1007.

FARM TRACTOR MANUFACTURER, well established, wishes to get in touch with large manufacturing property whose foundries and machine shops are capable of manufacturing at least 10,000 tractors per year including internal-combustion motors of 30 hp. 1016.

SUPERINTENDENT AND FOREMAN of power plant. Capable of taking complete charge of large smelter plant consisting of steam turbines, large blowing engines and rotary blowers, Diesel engines, waste heat and oil-fired boilers, pumping plant, high and low tension electrical equipment, etc. Must be familiar with combustion and operating problems; and have organizing and executive ability. Salary about $2500. Location Arizona. 1025.

DRAFTSMEN on miscellaneous mine and smelter equipment. Practical men with ten to fifteen years' mechanical and structural experience in shops, industrial plants and contract work, to act as squad leaders. Salary $190 per month, transportation refunded; 44 working hours per week; living expenses about $35 a month. Duration of employment not less than 5 months. Single men preferred. Location Copperclif, Ont., Canada. 1028.

GENERAL SUPERINTENDENT for plant with over 1200 employees near New York. Highly developed technique involving wide field. Applicant must have keen sense of justice and obvious ability to be successful executive in democratic organization. Thorough appreciation of importance of making deductions from facts alone; technical training. Men chosen for the position will be given opportunity to learn technique and establish himself in the confidence and esteem of the personnel. He will probably not be given full responsibility within a year. Plant is part of very large organization and affords ample opportunity for advancement. 1030.

ADVERTISING MAN. Boston advertising agency. Must be technically trained with advertising experience, preferably as advertising manager, and capable of taking full charge of accounts in engineering field. 1032.

DRAFTSMAN to make measurements and drawings of machine tools. Work will require considerable time. Good promise for the future. Young man of technical education and some practical experience, especially in machine tool work. Location Buffalo, N. Y. 1033.

PRODUCTION MANAGER. Age 35 to 45; married man preferred. Clean-cut, aggressive, of generous build preferred, executive ability. Technical graduate preferred, not absolutely required. Must have had actual shop experience in all departments, such as machine shop, drawing-room, tool designing, die making, etc. Thorough knowledge of design and operation of tools for press work absolutely necessary and familiarity with modern efficiency methods, including time studies, costs, planning, etc. Experience in electrical work desirable. Location vicinity New York City. Salary $3000 to $4000 or more according to qualifications. 1034.

FACTORY MANAGER, experienced in rubber industry, familiar with compounding and the different compounds. Salary $3000 to $4000. Location New Jersey. 1036.

MEN experienced in mill-room and press-room work of rubber industry. Day mill-room foreman. 1037. Night mill-room foreman. 1038. Foreman for press department. 1039.

MECHANICAL ENGINEER of some experience wanted for manufacturers of vegetable oils—linseed, castor, cocoanut, etc., crushing plants producing the raw material and refineries; young man out of college for five or six years, and engaged in manuacturing plant work. Knowledge of chemistry desirable, preferably both organic and inorganic. Absolutely trustworthy. Salary about $1800. Location New York State. 1040.

MASTER MECHANIC in long established manufacturing concern located near New York to take entire charge of construction, maintenance and repair departments, consisting of approximately 350 men. Must have experience and ability in organization, direction and efficiency methods. Excellent opportunity. 1041.

STEAM BOILER DESIGNER, experienced in water tube work. Location Erie, Pa. 1042.

REPRESENTATIVE AND SALES ENGINEER, especially in sugar house, and mill supplies; man from 25 to 35 years of age for manufacturer's agents, machinery and supplies. Would be required to spend about three months in Cuba. Knowledge of Spanish essential. 1043.

MECHANICAL ENGINEER for about six months' position having several years' experience in the efficient use of steam in industrial plants, to systematize, distribute, run tests and economize on steam used for power, cooking and evaporation in various departments of large chemical plant. Hours: 7—5.30. Salary $175. Location Brooklyn, N. Y. 1044.

SEVERAL INSTRUCTORS in mechanical engineering are needed by one of the large state universities in middle West, men having specialized training and experience in machine design, gas power engineering, and general laboratory work. Give complete statement of training, experience, minimum salary expected, and recent photograph. 1045.

INSTRUCTOR IN DRAWING, in large university in middle West. Technical graduate, preferably with drafting room experience. 1046.

YOUNG ORGANIZING ENGINEERS, for intensive management work, general manager's office, in one of the large units of the rubber industry. Opportunity decidedly promising. State initial salary expected, age, experience, qualifications, etc. 1047.

OFFICE EXECUTIVE for steel mill near Pittsburgh, competent to run office and direct men. Salary $125 monthly. Apply by letter. 1048.

MACHINE DESIGNER for automatic machinery for large rubber concern in northern Ohio. Prefer man with experience on machine tools. Pleasant surroundings, permanent position, opportunity for advancement. State age, education, experience, present and expected salary. 1049.

RESIDENT ENGINEER to superintend installation of foundations, buildings, gas machinery and piping. State experience and salary. 1054.

COMPANY manufacturing well-known food products desires mechanical engineer to study and improve methods of manufacture. Should have practical factory experience and be able to handle men. Good opportunity for energetic man. Location Long Island City. 1058.

TECHNICAL GRADUATE approximately 30 to 38 years of age with experience of sufficient breadth to be posted on problems of manufacture in more than one line. Man steadied by experience, yet ambitious to push ahead and interested in the various problems of manufacture and construction. Location Massachusetts. 1059.

ASSISTANT in mechanical laboratory of technical school in Greater New York. Recent mechanical engineering graduate with one or more years of practical work since graduation. Single man about 25 years of age preferred. Position offers exceptional opportunity for advancement. State age, education, experience, present employment and references. Enclose photograph with application. Salary $1200. 1060.

DESIGNER and lay-out man. Technical graduate with at least four or five years' experience in designing preferably on tools and fixtures, labor-saving and semi-automatic machinery. Location Michigan. 1061.

YOUNG MECHANICAL ENGINEER in cement plant, capable of designing machinery layouts, following up same in field and working into position of assistant superintendent. Give age, references and salary expected. Location Kansas. 1062.

SUPERINTENDENT for shipyard. Man experienced in the construction of wooden boats and barges. Eastern location. 1064.

FOREMAN in tool room of large factory making steel stampings. Salary to start $2000 to $2500. Location central New York. 1070.

YOUNG ENGINEERS desiring positions in which they might gain experience and advancement according to merit, in drafting room, in development of new and useful ideas and the improvement of old ones pertaining to oil well drilling tools. Salary $125 per month to start. Advancement according to capacity. Location Texas. 1071.

DRAFTSMAN familiar with piping layout of steam power plants, also assistant to chief draftsman capable of designing industrial buildings. Location Connecticut. 1074.

ELECTRICAL TESTER wanted immediately by Chicago blower manufacturer; will work as draftsman 20 per cent of time. Permanent with opportunity for promotion to salesman, designer or foreman. Salary $15.00 for first twenty weeks. Experience unnecessary. Describe education and physical condition. 1075.

GENERAL SUPERINTENDENT of shop employing about 500 men. Age between 35 and 42; technical education in mechanical engineering. Some knowledge of electrical and power-plant engineering. Experience in machine shop work, ranging from small fine interchangeable work, tool and jig design and manufacture, intricate machinery, to finish machining work weighing 30 tons calling for the use of 100" lathes and kindred machines. Well educated, of good presence, self-confident, self-reliant, and energetic. New York State. Apply by letter. 1076.

MEN AVAILABLE

Only members of the Society are listed in the published notices in this section. Copy for notices should be in hand by the 15th of the month, and the form of the notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

TECHNICAL GRADUATE, E.E. and M.E., some power plant experience; for last six years engaged as instructor in mechanical engineering in two leading technical schools. Desires position which offers opportunity for advancemenf in power plant or research work. Will be free after June 15th. F-199.

INDUSTRIAL ENGINEER AND DRAFTSMAN. Single, age 29. Five years experience on modern industrial accounting, planning and scheduling production, stores, determining standard tasks, standardizing equipment; designing draftsman industrial plants, special machinery and transmission work. At present employed. Good reason for desiring change. Interview New York City. F-200.

SHOP EXECUTIVE. Practical superintendent and technical graduate. Desires to locate in New York State or New England. Salary $3,000. F-201.

ASSISTANT TO EXECUTIVE. Graduate mechanical engineer, with eight years experience and some business training, can plan and follow up productive operations, wishes to engage with a growing manufacturing concern. F-202.

CONSTRUCTION ENGINEER. Stevens graduate, age 28, wishes connection with industrial company in construction or maintenance work. Has had seven years experience with large construction company for which he is now acting as purchasing engineer. Familiar with costs, specifications, and commercial as well as technical and practical features of building construction. F-203.

HEATING AND VENTILATING ENGINEER. Technical graduate. Seven years experience in design, installation and writing specifications for heating and ventilating and power plant equipment for group of buildings, industrial and public. Age 29, married. Minimum salary $2,000 a year. At present employed. Location immaterial. F-204.

MECHANICAL ENGINEER. Age 25. Technical graduate; power plant consulting, teaching, and some shop experience. Desires position with manufacturing concern where there is opportunity for advancement. At present employed. F-205.

TECHNICAL GRADUATE. Three years practical experience in boiler, gas and power plant work. Available latter part of June. F-206.

WORKS MANAGER. Graduate M.I.T., age 39. Thoroughly experienced in the manufacture and design of electrical devices and fittings, special and automatic machinery, armored cable, flexible metallic tubing and conduits, electro-galvanizing, sherardizing, etc. Specialized in the manufacture of interchangeable parts, applied for fifty patents, and had experience in patent litigation. Thoroughly conversant with modern shop organization, efficiency methods, production and handling men. At liberty June 1st. F-207.

MECHANICAL ENGINEER. Fifteen years experience in combustion and maintenance engineering. Would like to connect with large concern who wishes to improve conditions. F-208.

PRODUCTION ENGINEER OR SUPERINTENDENT. Successful executive. Technical graduate; 20 years experience in positions from foreman to manager. Experienced in revising plant management and in the introduction of modern systems. F-209.

MECHANICAL AND ELECTRICAL ENGINEER. Experienced in railway management. Twenty-four years practical experience. Can give good service in office management and administrative service, and assistance in organizing, engineering, maintenance or construction work. Knowledge and experience with materials of construction. F-210.

MECHANICAL ENGINEER. Age 47. Thorough and wide experience of 25 years in design and manufacture of general machinery, steam shovels, tank work, boilers, etc., including departments of correspondence, estimating, drawing room and shop construction. Desires agency or representation in City of Cleveland for outside representative and responsible firm. F-211.

ASSISTANT SUPERINTENDENT OR ENGINEERING EXECUTIVE. American, age 34. Eight years general engineering experience covering complete design, construction and maintenance of public utility properties. Energetic and ambitious. Has reached limit of advancement with present employers. Desires to connect with industrial concern within 300 miles of Chicago. Available upon three weeks notice. F-212.

SUMMER POSITION wanted by Junior Member with practical and teaching experience in drafting room, shop and laboratories. F-213.

EXECUTIVE OR SALES ENGINEER. Technical graduate. Past 15 years responsible charge of engineering work, construction, operation and management, together with several years experience as sales engineer. Desires position more or less executive. Salary to be commensurate with position. F-214.

MECHANICAL ENGINEER. Age 27. Columbia graduate. Five years experience in design, construction, and inspection with prominent concerns. Desires position in executive capacity, or as assistant with good chance of advancement. Employed at present, but will consider any fair offer. F-215.

WORKS MANAGER OR CHIEF ENGINEER. Graduate Stevens Inst. of Tech. Especially experienced along mechanical and operating lines; charge of design and tests of cars for city railway company, and operation of large steel mill for number of years. Assistant superintendent and chief engineer with well known firm of power transmission machinists and engineers. Experienced in production work in several types of industries for firm of consulting engineers. Salary $3,000-$4,000 depending upon character of employment. F-216.

ASSISTANT TO SUPERINTENDENT OR WORKS MANAGER. Technical graduate, 27. Four years experience as graduate student apprentice, time study man, rate setter and foreman of methods, with large manufacturing company. Available July 1st. Salary $1,800-$2,000. F-217.

MAINTENANCE-MECHANICAL ENGINEER. Graduate M.E. Columbia University. Design, inspection, shop maintenance and power house experience. Employed at present. Salary $30. F-218.

YOUNG ENGINEER. Age 26. Five years general machine shop experience, tool designing, and production work, graduating in mechanical engineering this June. Desires to locate with reputable concern in Southeast in production, efficiency work, or metallurgy. F-219.

ENGINEER, with experience in testing, operating, erecting, and repairing power house and boiler house equipment. Also experienced in various shop work. Technical graduate in steam and electrical engineering. At present employed but desires position with concern where there is chance of advancement. Location preferred in Western states. F-220.

MECHANICAL ENGINEER. Experienced in steam power plants, water works, compressing engines, rope drives, screw and pan conveyors, elevators and crushing machinery, and general mill machinery. Desires position with industrial manufacturing plant, in capacity of superintendent or master mechanic. Competent organizer and capable of handling men. Salary to be commensurate to position offered. F-221.

SALES ENGINEER. Practical machinist, technical graduate, experienced in drafting room, plant operation and selling. Age 31, married. Now holding position requiring salesmanship and good engineering ability. Desires change and would be available in 30 days to one looking for aggressive, capable man of integrity to push a line with merit, preferably on salary and commission basis. Willing to entertain straight salary or straight commission. F-222.

EXECUTIVE, ASSISTANT TO EXECUTIVE OR GENERAL MANAGER. Over 15 years experience in positions covering chief executive, office and works manager, consulting, construction, and efficiency engineering. Recent work has been in connection with manufacture of munitions. At present employed. F-223.

STUDENT MEMBER. Bucknell University. Graduate '17 in mechanical engineering course. Two years shopwork experience. F-224.

MECHANICAL ENGINEER. American, age 31, married. University graduate. Six years experience designing medium and light machinery. At present employed. Best references. Desires permanent and responsible position as designer or in any capacity in which experience will be available. F-225.

MECHANICAL ENGINEER OR PROFESSOR. Graduate M.E., age 34, married. Three years erecting buildings and machinery. Ten years teaching mechanical subjects as steam and gas engine laboratory and theory, operating and erecting during summers. Has first-class steam engineer's license and practical experience in operating and erecting boilers, engines, turbines, condensers, etc. Can plan work and direct workmen. At present employed. F-226.

INDUSTRIAL PLANT ENGINEER. Technical education; age 25, married. Five years practical experience. Desires position as superintendent of construction and maintenance, of factory buildings, and equipment with growing manufacturing concern where opportunity for advancement exists. Experience as designer of modern factory buildings and construction engineer on erection. At present employed, with good reason for making change. Salary expected not less than $2,000 per annum. F-227.

WORKS MANAGER OR ASSISTANT TO EXECUTIVE. Mechanical engineer, age 37. Technical graduate. Fourteen years varied experience in design, construction, and installation work, including ordnance design, ballistic apparatus, hydraulic machinery and structural steel. Well grounded in fundamentals of steam and electrical engineering. Thoroughly practical, with executive ability, not afraid of work or responsibility. Location preferably East or South. F-228.

STUDENT MEMBER graduating in June from the mechanical engineering course of well known university, desires position in any mechanical engineering line in New York, New Jersey or Connecticut. F-229.

PRODUCTION SUPERINTENDENT. Twenty years experience in manufacture of interchangeable parts and designing of tools and fixtures for rapid production. Experience in engine and automobile parts manufacturing. At present located with large factory in Middle West. F-230.

RAILWAY ENGINEER. Age 37. Technical education. Seventeen years experience as railway machinist, draftsman, chief draftsman and mechanical engineer. Desires position with railway company, supply house or industrial plant, with greater responsibility and opportunity. At present employed. Location immaterial. Salary $2,400. F-231.

FUEL TESTING ENGINEER. Desires position as combustion engineer for large user of coal. At present employed. Technical graduate, age 34. Seven and a half years experience in scientific testing of coal in industrial plants, for large coal company in Middle West. F-232.

SALES ENGINEER. Desires position as sales manager for coal-operating company. Graduate, experienced in scientific testing and selling of coal. At present employed. F-233.

WORKS MANAGER OR SUPERINTENDENT. American, age 45. Practical and technical. Thoroughly familiar with all branches of the manufacturing business from drawing board to sales, on steam, gasoline and oil engines—standard, marine and tractor—mining machinery, electric motors and generators A.C. and D.C. Vacuum machinery and since the war on 18 Pr. shrapnel 18 Pr. H.E. 6-in. and 8-in. Howitzer Specialized on efficiency methods, piece, premium and bonus systems, using unskilled labor as specialty men on accurate interchangeable parts, building and power plant construction. At present employed. Best of references. F-234.

DRAFTSMAN, MECHANICAL. Age 24. Experienced in the design and erection of steam power plants, wishes permanent position with power company, with chance of advancement. Not less than $115 per month to start. At present employed. F-235.

MECHANICAL ENGINEER. Sixteen years varied experience in testing, design, foundry, chemistry, metallurgy, special devices. Special aptitude for investigation work. Desires permanent connection with reputable concern leading to technical executive position. F-236.

RESEARCH OR EXECUTIVE POSITION. Technical graduate, eight years industrial plant experience, largely in chemical and steel industries. Demonstrated ability in work requiring originality, inventive ability and thorough understanding of technical principles. Effected important improvements factory and power plant designs and operations. Capable in handling of men and development of subordinates. Position should offer not less than $3,300 and opportunity. F-237.

EXPERT ENGINEER-SALESMAN. Graduate of leading technical school. Age 35. Desires connection as salesman or sales manager with concern manufacturing pumping machinery, air compressors, or internal combustion engines. Fourteen years sales experience in this line. Thorough, capable and aggressive and can secure results. Best of references from past and present employers as to integrity, honesty and ability. Minimum salary considered $2,500 per annum. New York City or vicinity; available on reasonable notice. F-238.

SUPERINTENDENT. Age 36. Practical tool-maker with 18 years experience in light and medium interchangeable manufacture and has held all positions up to and including superintendent. Desires change. F-239.

MANAGER, MECHANICAL AND MARINE ENGINEER; designer; college graduate, age 36, married, American citizen, speaks English, French, Italian, Spanish, some knowledge of German. Three years practical experience as marine engineer. Six years district manager of electric illuminating and manufacturing company. Six years experience in mechanical design of electrical machines with two leading American manufacturing concerns; expert calculating engineer. At present employed; five years in present position; open for engagement in U. S. or abroad. New York City preferred. F-240.

CEMENT MANUFACTURING DESIGNING ENGINEER. Cornell graduate with 20 years' experience designing, constructing and operating cement manufacturing plants, both wet and dry processes; broad engineering and executive experience, wishes to make permanent connection where results count. F-241.

INDUSTRIAL ENGINEER, CHEMICAL PLANT EXPERIENCE. Nine years' experience in design, construction, operation and maintenance of industrial plant machinery and power plants. Wide experience in purchasing materials, handling all classes of labor and chemical plant design and maintenance. F-242.

WORKS MANAGER. Mechanical engineering graduate, 37 years of age, having had several years' successful experience as factory manager, desires to make change. Prefers New England location with growing concern in which an interest may be secured. F-243.

EXECUTIVE POSITION wanted by American, technical graduate. Twelve years' experience in steel plant and general engineering work. At present employed. Will arrange for New York interview. F-244.

The question may naturally be asked by the busy manufacturer: "Of what special economic value is all this careful adherence to system and detail in the training of boys for factory work, and what are the results obtained for the outlay of money required to maintain the training department and school, with the necessary corps of foremen, assistant foremen, instructors for the class rooms, clerk, stenographer, etc.?" The answer is this: Every manufacturer knows there are times when it is practically impossible to secure enough good journeymen to fill the departments of his factory with competent, skilled help. He is often compelled to take into his shops unskilled labor and break them in on one or two operations in order to turn out the required amount of product. Furthermore, there is a demand at all times in the larger establishments of the country for skilled labor, and this is where the economic value of training boys and young men is plainly demonstrable.

Out of a force of 400 to 500 apprentices, approximately 120 will graduate each year from the four-year course and hold certificates as journeymen. From 60 to 80 per cent. of this number will remain in the factory for a longer period than one year, and it is safe to assume that a reasonable percentage will remain for an indefinite period.

What is the result? There is a constant influx into the factory of young men possessing not only a knowledge of one of the several trades necessary, but trained in the various shop practices and routine of the factory in which they have been schooled. If these young men remain for a term of years, the employer gains the advantage of their services during the most active period of life, when the energies of mind and body are at their best. Furthermore, the chances of their continuing loyal and faithful to their employer's interest during their term of employment are, on the average, much greater than would be the case with newly engaged employees coming from other and distant localities and having little or no interest either in the city or the factory in which they are employed.—*American Machinist.*

ENGINEERING SURVEY

A Review of Engineering Progress and Attainment in Mechanical Engineering and Related Fields, Including a Digest of Current Technical Periodicals and a Selected List of Engineering Articles

Notes from the Engineering Colleges

Equipment of Laboratories—Investigations in Progress—Changes in Curricula

AS a result of inquiries by THE JOURNAL, data have been secured from many of the schools and colleges which give courses of instruction in engineering, upon certain features of the professional work which they are undertaking. In particular, information was sought upon (1) characteristics of the laboratory equipment and the kinds of investigations in which the different institutions specialize; (2) tests or researches which have recently been under way or which are in prospect; (3) important changes in curriculum.

The replies have been summarized and the first installment of the information received is given below. In this connection, attention is called to the summary of what is being done by student bodies of the various colleges in military preparedness and service to the country, as recorded in the Student Sections' Department of this number of THE JOURNAL.

JOHNS HOPKINS UNIVERSITY

RESEARCH WORK

Separation of Tar from Coal Gas: It is hoped to develop a type of separator which will be simpler than those now in use and show an improvement over present methods of recovering the very valuable residues from the gas-manufacturing processes.

Cooling Water for Power-Plant Purposes: A new type of spray head or spray nozzle has been developed for finely dividing large quantities of warm water (Fig. 1). This can satisfactorily handle about 250 g.p.m. as compared with 40 or 50 g.p.m. in the case of other types. The capacity of the new nozzle and the fineness of division of the water are controllable from the side of the spray pond, and the nozzle can be flushed or freed from sediment or solid matter by operating the adjusting means. Probably the most effective known means for cooling water in large quantities is found in the forced-draft cooling tower, which is particularly effective because the cooling effect is controlled according to requirements. The newly developed spray head provides for complete control in a manner comparable to that of the forced-draft tower. The expense of installation and operation of a pond is very much smaller than that of a forced-draft tower. The investigation of the whole question of cooling water is still in progress.

Pumping Water with the Discharge from a Gas-Engine Cylinder: A device has been developed by means of which water can be elevated by attaching a spring-loaded relief valve to the cylinder of an internal-combustion engine and connecting it with the combustion chamber. Immediately after each explosion this valve discharges a certain portion of the hot gases through a nozzle similar to that of an ejector, and by the expansion of these hot gases through the nozzle, water is drawn from a suitable supply reservoir and is discharged through a pipe leading away from the relief valve. By this means large quantities of water have been elevated to a height of about 75 ft. Enough of the hot gas of explosion is left in the cylinder at each working stroke to cause the engine to continue to operate, in addition to pumping water. Upon closing the relief valve, the engine can carry the full load for which it is designed. This pump may have application in various regions where irrigation and reclaiming works are under way.

Concentration of Metal-Bearing Ores by Flotation: It is supposed that flotation is caused by the fact that certain oils will wet metal, while they will not wet or adhere to non-metal-bearing rock dust. Ordinarily compressed air is blown into the mixture of ore and water and oil. It has been found necessary in many cases to heat the air or the water, and further,

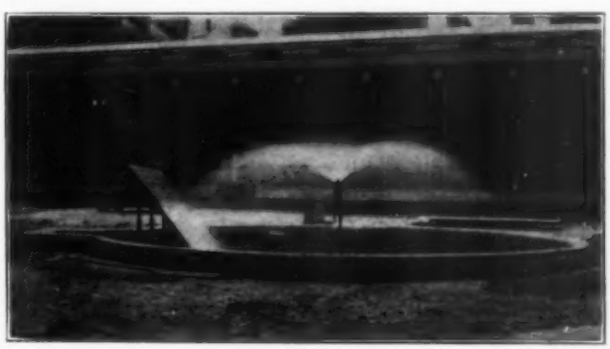


FIG. 1 NEW TYPE OF SPRAY NOZZLE

to supply some carbon dioxide with the air. The discharge from a gas-engine cylinder is not only hot, but it contains something like 10 per cent of carbon dioxide, and the gas-engine discharge makes an excellent agitating medium, because of the high velocity with which it is discharged from the cylinder. These facts have led to the development of an agitator for use in the flotation process. The means are similar to those above described for pumping water. In both cases it is not the ordinary exhaust from the engine which is used, but high-pressure gases which would otherwise remain in the cylinder during the working stroke of the engine. Tests made show that a very satisfactory concentration is obtainable, and tentative arrangements have been made for trying the method at a mine.

Cleaning of Used Lubricating Oils: A new type of agitator for liquids has been developed, suitable for producing very minute subdivisions of liquids containing finely divided solids. It has been applied to clean used lubricating oils, particularly those of automobiles, trucks and the like. By the use of the agitator the finely divided carbon or other solid matter can be very easily and cheaply separated and the oil rendered suitable again for its original purpose.

Smoke-Stack Design: The smoke stack of the university power plant was designed with a view to investigating impor-

tant problems, and means were provided for taking accurate and extensive measurements of pressures, velocities, temperatures, etc., during the operation of the plant. Various problems are being investigated.

Measurement of the Air Required for Combustion in Furnaces: Means have been provided for measuring all of the air supplied to the Taylor stokers under two of the boilers in the power station. The determination of the size of blowers and the engines for operating them depends directly upon a knowledge of the amount of air required. This matter affects not only the operation of boiler furnaces, but also furnaces used in connection with the iron and steel industry in metallurgical processes. Some tests have already been concluded.

Losses in an Ammonia Refrigeration System: A very complete ammonia-compression system for artificial refrigeration is available in the mechanical laboratory, and an investigation is under way for the determination of the losses of energy and the locations at which they take place. Means have been provided for accurately measuring the quantity of brine circulated in the refrigerating pipes; and this means of measurement is being utilized for another investigation, namely, the determination of the coefficient of discharge of a hydraulic weir when brine of varying temperatures and densities is passing the weir.

Cracking of Petroleum Vapors: The 125-hp. Diesel engine in the laboratory has been used for compressing petroleum vapors to a high pressure in a very brief period of time, with the object of producing separation of the vapors into such products as gasoline, etc. An investigation of this problem has been carried on, and it is expected that the results will be published at an early date.

Recovery of By-Products from the Distillation of Carbon in the Manufacture of Coke and Gas: In response to the demand among the industries for specific information for the production of artificial dyes, drugs, explosives, etc., a laboratory is being equipped for work in this important field. A fund of about $6,000 has been subscribed by the principal gas and coke companies of this country, and the equipment is now in process of erection. The instruction and operation of the plant will be conducted jointly by the Department of Mechanical Engineering and the Department of Chemistry.

LEHIGH UNIVERSITY

Equipment: Engineering testing laboratory, also physical, electrical, chemical, metallurgical and mining laboratories. The engineering laboratory has a boiler equipment of two water-tube boilers rated at about 100 hp. each. In the heat and light plant there are three 250 hp. Stirling boilers. The engine room of the laboratory contains a vertical triple-expansion engine of 75 hp., a 60 hp. compound two stage Ingersoll air compressor, a complete set of Westinghouse air-brake apparatus, two large condensers, a large belt dynamometer, a Cochrane feed-water heater of 250 hp. capacity. The engine room of the power house contains units of 50 and 100 kw. rating. Simple horizontal Ball engines are direct connected to General Electric alternating current generators.

The laboratory for testing materials contains a general testing section for iron and steel, a cement and concrete section, and a hydraulic section. An electric traveling crane of 10 ton capacity commands the entire central portion of the building in which the testing of large specimens is carried on. The general testing section is equipped with an 800,000-lb. Riehle vertical screw testing machine; an Olsen universal testing machine of 300,000-lb. capacity; smaller machines for ordinary tension, compression, transverse and torsion tests.

The mining laboratory consists of a gyratory crusher, rolls, screens, jigs, Huntington mill, classifiers, concentrators, gravity stamps, amalgamating plates, grinding pan, and cyanide plant, with the necessary apparatus. The laboratory for testing samples contains a small jaw crusher, a small gyratory crusher, rolls, sample grinder, a magnetic separator, and a small air compressor. A special department is equipped for flotation methods.

Experimental Work: Determination of the coefficient of expansion of silica brick; physical tests on properties of concrete columns.

COLUMBIA UNIVERSITY

Equipment: Only about 10 per cent of the research work in the mechanical-engineering department is done at the university, so that the laboratory equipment is used mainly for teaching.

Experimental Work: Tests for obtaining data alone are only casually undertaken and then only under special circumstances. The regular laboratory work for students is conducted on lines which are distinctly research in character. Ninety per cent of the research work is done in the field and consists not so much in research but in what is called development work—taking an invention, putting it into practical form to see whether it will work and modifying it until it does work. This work is all done for interested parties.

Development Work: The skill and experience of the research staff is reserved for development work in which there is a distinct commercial or scientific end clearly in sight before the start. People who do the work are the instructing staff and the employees of the firms interested in results. The work is paid for by the firms. Students are rarely used and when they are used, they are only permitted to make readings or make calculations on results. All kinds of researches are undertaken except on material of construction and on pure mechanism. The former are taken care of in the civil engineering and metallurgical and mechanical engineering departments of the university. The latter are also taken care of elsewhere. Some design work in pure mechanism in developing new machines is undertaken, however, this design going hand in hand with the shop work. The nature of the subject-matter of the researches undertaken is almost entirely thermal or chemical. The work is concentrated on processes of a thermal or chemical nature and equipment for properly carrying them out. The work ranges from small isolated problems to problems of large plant installations. Following is an outline of the organization as proposed:

Industrial Development Laboratories: These are to be created for the purpose of promoting the welfare of American manufacturing institutions through

a Furnishing equipment and the services of the best scientific thought in creating, perfecting and introducing improved methods of economic production of commodities and industrial services

b Training engineers in the science of industrial development to the establishment of more economic operating conditions in manufacture.

This service might be rendered through the following means:

a Transposition of new and important principles into industrial and operating units and their perfection into com-

mercial possibilities; for example, the discoveries made by the chemist in his laboratoray might be worked out on a manufacturing scale and plans and specifications may be made available to the manufacturer in developing new lines of industry or in perfecting old ones

b Analysis and development of old processes and their modification and improvement to meet modern economic requirements

c Improvement of physical equipment of plants and methods of business management thereof

d Plant appraisals and reports for financial, legal and ownership interests

e Public service; for example, through these laboratories may be had the best information on the engineering problems arising in municipal and state governments; municipal engineers and engineering commissioners will be able to avail themselves of the best assistance in the erection and maintenance of public works, municipal light and gas properties, drainage, sewers, garbage disposal, street cleaning, paving and many other engineering activities of a municipality.

f Laboratory research on problems of allied interests; as, for example, ascertaining the cause of the failure of rails, the failure of concrete structures, the corrosion of steel structures, the rational conservation of natural resources, such as more economic methods of mining, more economic power generation, more economic methods of distributing commodities and such problems

g Service to the national government in connection with the Army and Navy equipment, etc.

The plant proposed for this purpose includes the following buildings:

Chemical Industries: Electrochemical laboratory, furnace laboratory, distillation laboratory, wet-reaction laboratory, destructive-distillation laboratory

Mining Industries: Mining laboratory

Metallurgical Industries: Metallurgical-processes laboratory, ferrous and non-ferrous; metallurgical-analysis laboratory

Electrical Industries: Electrical-development laboratories

Manufacturing and Transportation Industries: Aeronautical laboratory, marine laboratory, transportation building, machine-design building, hydraulic laboratories, refrigeration and compressed-air building, steam-engineering building, steam-boiler and furnace building, gas-power building, heat-transfer laboratory, mechanical-standard building and development shops

Administration: Administration building, power, heating and lighting plant.

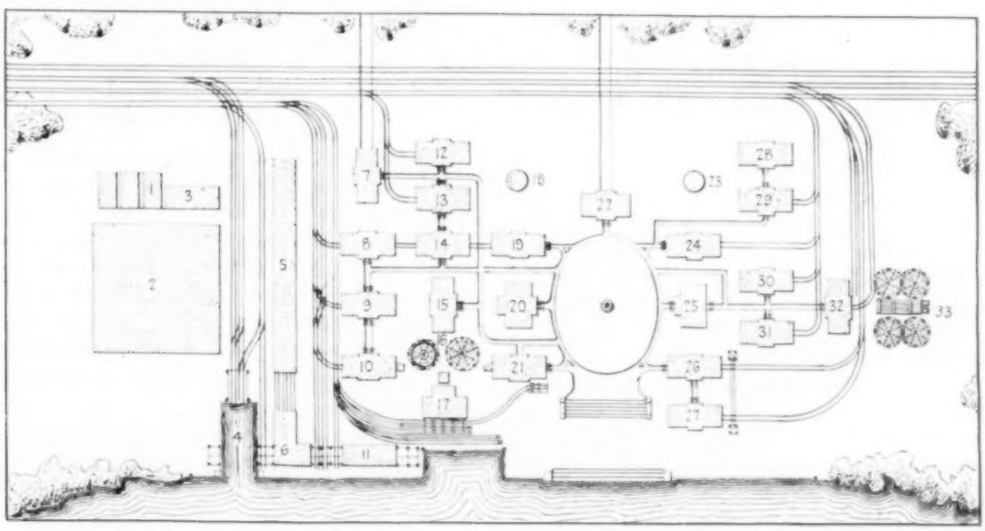


FIG. 2 PROPOSED INDUSTRIAL DEVELOPMENT LABORATORIES FOR COLUMBIA UNIVERSITY

1	Hangars	12	Shop	23	Water Tank
2	Aviation Field	13	Shop	24	Mining
3	Aeronautical Laboratories	14	Machine Design	25	Chemical Laboratory
4	Slip	15	Refrigeration and Compressed Air	26	Electrical Laboratory
5	Model Tank	16	Gas Tanks	27	Electrical Laboratory
6	Marine Laboratory	17	Power House	28	Metallurgy
7	Transportation Building	18	Water Tank	29	Metallurgy
8	Shop	19	Heat Transfer	30	Chemical Laboratory
9	Steam Engineering	20	Mechanical Standards	31	Chemical Laboratory
10	Steam Boiler and Furnace	21	Gas Power	32	Chemical Laboratory
11	Hydraulic Laboratory	22	Administration	33	Gas Tanks

The approximate cost is given at roughly two million dollars, to which must be added a like sum for the purchase of the necessary land. A proposed layout is given in Fig. 2.

Publications: Most of the material of the researches is not published because it is obtained for private parties. However, sometimes some of the results are in the form of principles of general interest which could properly be published, and the department promises in future to ask permission of its clients to publish material through the Society.

Curriculum: Theses are no longer required, and the time thus gained is devoted to direct work. This year is the last of the four-year courses of the old style. There is still one class left to be graduated this year. Next year is the beginning of the complete operation of the three-year engineering courses preceded by three years in college. This will put engineering in Columbia on the same basis as law and medicine. So far Columbia is the only institution in America which has established the three-year courses in engineering.

Massachusetts Institute of Technology

Equipment: The new engineering laboratories cover an area of about 70,000 sq. ft. Before planning the laboratories a study was made of the equipments of other engineering schools both in this country and abroad. Leading steam, hydraulic, and refrigerating engineers were asked to criticise the preliminary plans and assistance of great value was obtained through this means. The equipment of the laboratories was selected with the following objects in view: first, to give a student practice in such experimental work as an engineer in the pursuit of his profession is called upon to perform; and second, to provide ample facilities for original investigation and research in engineering subjects. The laboratory is divided into six branches, material testing, steam and compressed air, hydraulics, power measurement, refrigeration and gas engine, and an expert in the particular line of experimental work is in charge of each branch.

Experimental Work: Design and construction of a machine for testing the crimp in tire fabric; tests of the relative wear of knit goods and design of machine for this purpose; economic investigation of central station conditions in several towns to determine whether or not the respective loads can be more economically operated from a common source; study of the effect of pressure on the temperautre at which spontaneous combustion of liquid fuel (gasoline, kerosene and some heavy oil) takes place; investigation of the heating of an automobile tire; study of the relative strength of rolled and cut screw threads in soft steel bolts; study of the theoretical possibilities of the different refrigerants and of various domestic refrigerating machines on the market, to determine those most desirable for domestic use; investigations of the effects of high-pressure steam on power plant operation; investigation of the strength of rivets due to duration of heating; determination of the respective lengths of copper, iron and brass pipes to give best economy in water heaters; investigation of the physical properties and performance of the Baush Universal joints; investigation concerning the effect of rest, after over-straining, on the elastic limit of steel; design of a hygrometer; investigation of the strength of phosphor bronze under varying thermal conditions; investigation of the strength of steel in the blue heat region; effect of reabsorbed moisture on fir and pine timber; study of wood preservatives; investigation of the effect of different sizes and aggregates in bituminous pavements; investigation of skew and plain arches of the same general dimensions; investigation of oyster shell concrete; effect on concrete of the time of mixing; study of the effect of various waterproofing compounds on concrete; effect of steam on concrete; strength of various types of rope; study of substances to prevent cement from setting; strength of magnesium alloys; strength of composite cables; strength of glue.

Leland Stanford Junior University

Equipment: The laboratory includes a good selection of apparatus for experimental work in fuel analysis, power plant work, automobile testing, friction and lubrication, refrigeration, hydraulics, hydraulic machinery, and aerodynamics. The laboratory for aeronautics has been developed along original lines in many respects. While it comprises the usual tunnel for testing models in an air-current, the main purpose at present is to carry out tests of various propellers. In this connection several novel instruments, permitting to carry out measurements of very high precision, have been developed. An interesting feature of some of these instruments is the application of the telephone receiver for location of the exact points in space or time which it is desired to determine for the purpose of measurement. The use of the telephone receiver in such connection, by no means usual in mechanical measurements, permits a considerable simplification of the measurement itself without sacrificing of the precision and to a certain extent eliminates the personal equation of the experimenter.

Experimental Work: Tests on oil heaters and coolers; investigation relating to thickness of oil film in journal; investigation on flow of oil in pipes in cooperation with the U. S. Bureau of Mines; investigation of air propellers for National Advisory Committee for Aeronautics; research on strength and durability of gear teeth under grant from Engineering Foundation.

Curriculum: The courses of instruction have been recast to fit in with the four-quarter system which the University has adopted, to become effective in the next academic year.

Case School of Applied Science

Experimental Work: During the past year the mechanical engineering department has made a special study of the fuel problem in Cleveland, and has been devoting its energy to the saving of coal in several of the small and moderate-sized independent power stations in and around Cleveland. The fuel problem has been a very acute one in Cleveland during the past year, as indeed it has been all over the country. Since the department is very well equipped to handle such problems, it can do the most good in devoting its energy in this direction.

Curriculum: Additions have been made as follows: a special course on the manufacture of high explosives and shrapnel, shells and time fuses; a course in field surveying adapted to military needs; modifications of the courses in physics and electrical engineering, directing the attention of the students to the application of electricity in warfare.

University of Washington (Seattle)

Equipment: Usual apparatus for student experiments on steam and gas engines, air compressors, and structure of materials; provision for research work on a 27-hp. gas producer, involving the use of mill refuse and bark; on a 2-ton refrigerating compressor plant; on lubricating oils; and on fuels. A dynamic balance for measuring wind pressures is being installed in the wind tunnel and it is expected to carry on an extensive series of tests on aerodynamical engineering problems.

The growth of ship building in this vicinity has been so great that the department expects to add a number of naval architecture subjects for the coming school year, and a new man to carry on some of this work and to handle the aerodynamic laboratory will be appointed during the coming summer.

Curriculum: Changes are proposed involving reduction in hours for mathematics, so as to have calculus for a year only, unifying the engineering courses for the first year at least, and the addition of a course involving engineering problems for the freshmen. This course is to be so arranged as to attempt a training in method and concentration, as well as to give insight into the nature of the work to be found in each of the engineering departments.

News of Other Societies

National Association of Cotton Manufacturers' Convention

THE convention met at the Copley Plaza Hotel in Boston, April 25 and 26, and was one of the most notable in the history of the organization as regarded attendance and interest of the program. It was also more diversified than usual, as it included in its numbers many representatives of other textile associations, from the South, West, and Canada.

The most important feature of the convention involved the report of the Committee on Enlarging the Scope of the Association. The general idea of broadening the activities of the association met the hearty approval of practically the whole membership. An essential feature of this broadening is the creation of a new class of membership—to be known as Sustaining Members, who shall contribute to the funds of the association on a payroll basis, no annual assessment being less than $50, nor more than $500. These sustaining members will enjoy the full privileges of active members and will also be entitled to such direct service as the National Council may be able to render.

The program differed materially in general character from those usual in former years. No printed papers were distributed, and, with the exception of the session on Wednesday afternoon, the topics under consideration were arranged in groups under the direction of different chairmen, who opened the discussion of subjects on which various members had come prepared to speak. This plan proved of greater interest and led to wider participation in the debate.

A number of technical papers were presented. John A. Stevens, Mem.Am.Soc.M.E., discussed the evolution of the steam turbine in the textile industry. He pointed out how from surprisingly small beginnings in 1883 the steam turbine has grown to such proportions that it has invaded practically every field formerly occupied by the steam engine, which is due to its many advantages as compared with the reciprocating engine, which advantages he carefully enumerated. It is an undisputed fact that the turbine in sizes over 1000 kw. has superseded the steam engine, and even in sizes 200 to 1000 kw. the advantage is still in favor of the turbine, particularly in sizes of over 500 kw. He covered the subjects of low-pressure turbines, mixed-pressure and bleeder types, and the use of reducing gear, and gave illustrated descriptions of representative mill installations. It is expected that a more complete abstract of the technical features of the paper will be given in an early issue of THE JOURNAL.

Representatives of the Federal and Canadian Bureaus of Forestry and of the Southern Pine Growers' Association gave several papers on mill roofs and decay of timbers.

Arthur N. Sheldon, Mem.Am.Soc.M.E., discussed the conductivity of mill roofs and methods for preventing condensation. He brought out that a certain thickness of roof is necessary for a given humidity, the thickness increasing as the humidity increases. The paper is based on experiments with concrete and plank roofs with various kinds of insulation. In the course of the paper the speaker pointed out that if the temperature of the underside of the roof coincides with the dewpoint for the particular humidity and temperature in use, there will be condensation. If the temperature of the underside of the roof is above the dewpoint, there will be no condensation on the underside of the roof, but condensation will take place somewhere in the interior of the plank, depending upon the heat gradient between the inside and outside temperatures of the roof plank. Hence, while it is easy to design a roof which would have no condensation on the underside, it is practically impossible (unless at considerable expense) to design a plank roof with no condensation on the upper surfaces, or somewhere in the interior of the plank. The speaker proceeded to give a comparison of a concrete roof properly insulated and a wood roof of proper thickness and insulation to prevent condensation. A diagram was shown indicating that a thickness of the roof plank of a little over 3 in. would be required, while a 4-in. concrete roof plus 1 in. of cork board would give approximately the same insulation. The prevention of condensation on the underside of the roof planks does not, however, eliminate the possibilities for decay, because there is always condensation between the roof covering and the roof boards during cold weather. It would therefore seem absolutely necessary to treat the wood timber to prevent decay.

Methods for identifying fungus growths were discussed by H. N. Lee, of the Forest Products Laboratory, McGill University, Montreal. The speaker outlined a course of investigation from which he hopes to be able to determine just what fungus is doing the damage to any wood, even if the fungus has not produced any characteristic fruiting body by which it would be immediately identified. He even hopes to be able to tell it from the effect on the wood itself when the fine threads of the fungus do not show. When this is done, any one having trouble from wood decay will have only to send to the laboratory a sample of the wood and the laboratory should be able to tell what fungus is at work; then as soon as this matter is worked out, it can be determined what change of humidity conditions is necessary to stop the development of the fungus, and with it the rotting of the wood.

At the banquet on Wednesday evening, April 25, Henry E. Crampton delivered an address on the Council of National Defense and the Cotton Industry. The speaker stated that there is a comprehensive plan being followed by the advisory commission of the Council, and a great deal more is being done than gets into the newspapers.

The papers of the Thursday session, April 26, were devoted to commercial matters and questions of health insurance, factory safety and sanitation.

A very complete and careful account of the proceedings of the convention will be found in the *Textile World Journal* for April 28, 1917, from which the facts of the present account were mainly taken.

National Electric Light Association Convention

INSTEAD of meeting at Atlantic City, as originally arranged, the National Electric Light Association changed its plans because of the war and held this year's convention in the Engineering Societies Building, New York, May 9 and 10. As characterized by the *Electrical World* of May 12, from which the main facts of the following account are taken, it was essentially a war convention. From the opening words of the president, Herbert A. Wagner, to the final adjournment, half a day earlier than anticipated, the serious responsibility resting upon the industry to make the best use of its facilities for the country was the dominant note of the business transacted.

The proceedings of this convention in their outward manifestations were vastly different from the usual sober and humdrum course of meetings of engineering bodies. Follow-

ing the appointment of the committee on the President's address, a bugle was sounded, a squad of khaki-clad men marched in and the flag was raised, while the convention joined in the patriotic strains of "America."

The question uppermost in the minds of those in attendance, as to "How can we best serve?" was answered in the Public Policy Committee Report by saying that both as companies and as an industry the members of the N.E.L.A. can most effectively serve the nation by a continued maintenance of reliable service on the part of the public-service utilities, by conserving the health and safety of the public, and also by furnishing information and assistance to the Government through its organizations and technically trained men.

John W. Lieb, Mem.Am.Soc.M.E., who was elected war president of the association, spoke informally and presented interesting information on experiences in England, where the arguments of the companies supplying electricity secured temporary exemptions from call to the colors for their most important men, which gave them time to rebuild their organizations. He also called attention to the great difficulty of making the proper adjustments for the care of dependents of employees who go to the front without at the same time bankrupting the companies, and stated that it is still a moot question as to what may be exactly the best policy to be pursued.

The same problem was discussed by J. E. Aldred, who has large business interests in Montreal, Canada. While the original intention was to pay the men who went to the front the difference between their regular wage and what the Government gave them in the service, the plan was abandoned afterwards, to some extent, in favor of what is known as the Patriotic Fund. This, however, was not because the burden imposed on the companies by the former plan was excessive. In fact, the proposition not only stimulated enlistment, but also helped maintain the efficiency of the force left at home, so that in the case of the Montreal Light, Heat & Power Co. 30 per cent more business was done than in any previous year of its history. The change to what is known as the Patriotic Fund resulted from pressure from the agricultural sections.

L. A. Ferguson, Commonwealth Edison Co., Chicago, described a plan adopted by that company, but tentative to the extent that it is definite only until August 1. This is based on the theory that the company shall not pay anything to the man himself who goes to the front, but that it shall provide for the dependents he leaves at home.

Of the papers presented in the technical sections, the one of greatest interest to mechanical engineers is the report of the Prime Mover Committee, of which J. M. Graves, Mem. Am.Soc.M.E., is chairman. The report discusses turbines, condensers, station auxiliaries, stokers, refractory materials, coal handling and storage, weathering and spontaneous combustion of coal, etc. Feasibility and practicability of higher steam pressures, condenser cleaning, economical steam velocities and pressure drops, station instruments, analysis of power requirements of station auxiliaries, and treatment of boiler feedwater are also discussed, and comments made regarding Diesel engines, progress of waterpower development, operation and maintenance of hydroelectric stations, ice-handling methods and waterwheel testing.

The report states that there has been a great increase in the number of orders for large prime movers, the development of large condensers, boilers, stokers, and auxiliaries keeping pace with the development of the turbine. The largest turbine so far developed is rated at 70,000 kw., and the largest condenser on order has 100,000 sq. ft. of tube surface.

The tendency in regard to circulating pumps is in the direction of more water per pound of steam. With steam-turbine drive the general trend is toward high turbine speeds. Development work during the past year has been along the lines of adapting the underfeed stoker to high-ash Middle Western coal and to lignite, both of which are now being handled with entire satisfaction.

Owing to the increased rating of boilers the firebrick surfaces have been proportionately increased and higher temperatures have produced greater expansion and contraction in them, so there are more frequent failures both in arch and side walls. Various methods have been tried to strengthen the flat walls, but with little success. Buttresses built inside of the combustion chamber were burned off in a very short time. Sheet-iron linings were also tried, but were melted down as soon as the firebrick inside had been burned away or partly destroyed by slag.

Several pages of the report are devoted to an extensive discussion by J. A. Walls on the question of protection against different forms of ice, including frazil and anchor ice. It is pointed out that if the first formation of frazil ice is not quickly observed, the ice will accumulate so fast as to make a shutdown inevitable. One means of detecting the onset of frazil or ground ice is to immerse a chain in the flowing water of the forebay and examine it every half hour or oftener. Frazil or anchor ice cannot form until the temperature of the water drops to freezing; hence a graphic thermometer will, in many cases, serve as a warning against any danger which may threaten from this cause.

National Fire Protection Association

AT the annual meeting of the National Fire Protection Association, held at Washington, D. C., May 8-10, the main subject for discussion was the new and unusual fire hazards and danger to life and property created by the state of war, and which demand the utmost vigilance on the part of the state, municipalities, and private individuals. Definite recommendations were made which included the following: The adoption by municipalities of the standard building code of the Board of Fire Underwriters, and by the state, of minimum building requirements for its public institutions; the enactment in each state of a fire marshal law; inspection of buildings by city fire marshals; levying the cost of extinguishing preventable fires upon citizens disregarding fire-prevention orders; more extended use of the automatic sprinkler; study of the technical survey of cities made by the Board of Fire Underwriters in regard to fire risks and efficiency of fire fighting apparatus, and the education of the children and the public generally in careful habits regarding the use of fire.

Among the reports discussed were the following of particular interest to mechanical engineers:

Uses of Wood in Building Construction. Containing a new standard for mill construction, with data on the decay of wood and its prevention; and the strength of timber and how to calculate it.

Roof Openings (skylights) and Cornices.

Standards for Pipe and Pipe Fittings. Containing specifications and tabulated dimensions of sprinkler pipe fittings, including long-turn fittings.

Explosives and Combustibles. Dealing mainly with fuel oil, acetylene gas for welding and lighting, and gasoline, with sug-

gestions regarding the safety of acetylene apparatus and the safe use of motion-picture film.

Safety to Life. Dealing, first, with the number of occupants permissible in a building, basing the number on the stair capacity with a view to safe exit in case of fire; and second, classification of the occupants of buildings by inflammability of materials manufactured, stored or used. The first part of the report is comprised mainly of a tabulated form showing the capacity per unit of stair width, and the second part of an elaborate list indicating the materials manufactured or handled and the risk involved according to whether the property would be considered as of "low inflammability," "moderate inflammability," or "high inflammability."

Ammunition Manufacture and Safeguarding of Industrial Plants. This timely paper treats mainly of the situation existing in the manufacture of artillery ammunition and of small-arms ammunition.

A brief description is given of the types of shells and cartridges used and of the processes of manufacture. Suggestions are made for safety in manufacture, and the important feature of guarding ammunition plants which are subject to attack by agents of an enemy is considered, with definite recommendations calling for such provisions as the following: adequate fencing in of property; armed guards; adequate lighting of yard and fences; wiring fences with charged electric wire connected with tell-tale device which will give a signal in case of a short-circuit; bars or screens at windows; patrol organization, etc. The report goes into these matters very fully and in detail.

Fire-Resistance Construction. The important feature of this report is the discussion of what has been designated as "full," "partial" and "temporary" protection in order to indicate the fire-resistance qualities of various materials and types of construction.

Conferences have been held by representatives of various associations, including The American Society of Mechanical Engineers. The representatives of the Society were Ira H. Woolson, Chairman of the committee which prepared this report, and W. C. Mowry, appointed by John R. Freeman, Chairman of the Sub-Committee on Fire Protection of The American Society of Mechanical Engineers.

At these conferences it was decided that the terms "full," "partial" and "temporary" should be superseded by terms indicating time, such as 4-hr. protection, 2-hr. protection, 1-hr. protection, etc. A time-temperature curve, shown in the accompanying diagram, was adopted to indicate standards of fire resistance. A scientifically-determined time-temperature curve is regarded of so great importance that it has been proposed to make the subject one for discussion at the next annual meeting of The American Society of Mechanical Engineers.

Protection of Openings in Walls and Partitions. In this report a feature of importance relates to the control of automatically-closing fire doors in buildings. A definite recommendation is made for the use of apparatus the operation of which depends on the rate of temperature rise, to replace fixed-temperature devices such as now used. By such improved apparatus the door will be closed in case of rapid rise of temperature before a fire will have an opportunity to sweep through the doorway and endanger the contents of the adjoining room, as so often happens with the fixed temperature device, which does not operate until a certain predetermined temperature has been reached. The mechanism of the device which has been recommended is of considerable interest. When a rise of temperature occurs equal to 15 deg. or more, within one minute, the air in an inclosed chamber expands a diaphragm plunger and sets into operation a series of releasing levers. Under ordinary conditions the air in the chamber is maintained at atmospheric pressure through the medium of a vent, which is calibrated to permit rise in temperature of

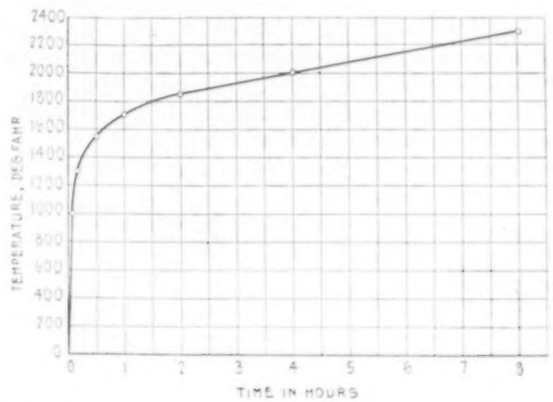


FIG. 3 TENTATIVE STANDARD TIME-TEMPERATURE CURVE FOR FIRE TESTS OF BUILDING CONSTRUCTION

(1000 deg. at 5 min.; 1550 deg. at 30 min., etc.)

less than 15 deg. per minute without producing pressure enough to operate the diaphragm.

The secretary of the National Fire Protection Association is Franklin H. Wentworth, 87 Milk St., Boston.

AMERICAN CHEMICAL SOCIETY

The 54th meeting of the American Chemical Society was held in Kansas City, Mo., April 10 to 14.

Like all meetings at this critical period in the life of the nation, that of the chemists was held under the red star of war. The following resolution was unanimously passed by the assembled members: "Resolved, that we reaffirm the tender to the President of the United States of the services of the members of our Society in all the fields in which we are qualified to act. The progress of the war thus far principally teaches us that modern warfare makes extraordinary demands upon science, food supply and finance. For the protection and success of our men under arms we recommend the use, in their respective fields, of all trained chemists, physicists and medical men, including advanced students of these subjects. to this end, in collaboration with the United States Bureau of Mines, we are preparing a census of chemists. With no desire to avoid field service for men of training in the professions named, we urge that those of special ability be held to the work they can best perform. Thus we may avoid unnecessary loss from lack of control of the tools and requirements of war."

In the afternoon a public session on petroleum and natural gas was held, at which several papers were presented. Of particular interest to mechanical engineers are those of H. C. Allen and E. E. Lyder, on Variations in the Compositions of Gas of the Mid-Continent Field, and E. P. Fisher, on Some Experiences in the Use of Oxy-Acetylene Welding in Long Distance Natural Gas Transportation.

The temperature of a boiler tube is within 10 to 20 deg. cent. the same as that of the boiler water, and the temperature of the tube is affected very little by the temperature of the hot gases, but follows the temperature of the boiler water.

A Reference to the Spring Meeting of 1916

AT the meeting of the House of Representatives on May 7 (all quotations are taken from the New York *Times* of May 8) Representative John Q. Tilson of Connecticut, a Republican member of the Military Affairs Committee, discussed the manufacture of United States rifles, and disclosed the fact that only a very limited quantity of such rifles can be manufactured for the United States Government within a reasonable time because of the difficulty of procuring gages.

"Do you think that is good information to make public?" asked Representative Robbins of Pennsylvania.

"Everybody knows it except ourselves," replied Tilson. "All our enemies know it."

It is interesting to recall in this connection that the facts stated by Representative Tilson on May 7 were convincingly brought forward more than a year ago by members of The American Society of Mechanical Engineers at the Spring Meeting of 1916, New Orleans, in the discussion of Mr. Spencer Miller's paper on Organizing for Industrial Preparedness.

Among others, F. O. Hoagland stated that while the Government has at times placed small contracts for rifle-ammunition manufacture, no private manufacturer has ever made the 0.30 Springfield rifle, nor has he any special tools, fixtures, or gages necessary for making them. Quick service is not to be expected unless several of these concerns are placed in condition to meet the demand. Mr. Hoagland estimated that it would take about twelve months to prepare the special equipment of fixtures, tools and gages necessary for the production of, say, 100 military rifles per working day, and about half that time to prepare for 100,000 cartridges per day even when a factory has at the start a fair organization for similar work. The Government arsenals could be of great assistance in preparing the special equipment of fixtures, tools and gages, but a few leaders and workmen in each plant who are thoroughly familiar with the requirements are absolutely necessary in order to get quick and sure response.

In a joint discussion of the same paper, Frank O. Wells and Charles E. Smart pointed out the need for our machine shops to be equipped to manufacture munitions of war at short notice. While for over two years all the machine shops in the United States had been working for the Allies, yet new designs for jigs and fixtures were still upon the drawing boards and new gages and tools were being made in hundreds of shops all over the country. As a conservative estimate, they said, it would require 50 engineers, designers and draftsmen at least 50 weeks to prepare the drawings for the 17 sizes of shells now used by the United States Army, together with drawings for gages, fixtures and tools. To produce the latter would require probably 800 men well trained and in well-organized factories at least five years, calculating 300 working days per year. And this does not cover the question of aeroplanes, rifles, battleships, or a large number of other imporant parts of equipment which also must be provided for.

The manufacture of rifles formed the subject of a communication by Fred E. Rogers luminously covering the very points which Representative Robbins doubted the wisdom of making public at the present time. "The manufacture of rifles," wrote Mr. Rogers, "is a complete process, requiring special skill and experience, and with the exception of our Government arsenals, there was at the outbreak of the present war perhaps not one plant in the United States properly equipped and manned for manufacturing military arms. There are about 800 principal machine operations involved in making the parts of the simplest military arm, including the wood stock and hand guard. Many of these operations require special machinery, and practically all the parts must be in jigs or fixtures while machining. When we consider the fact that to provide equipment for an army of 1,000,000 from 2,000,000 to 3,000,000 rifles are required, the size of the task of equipping an army of 1,000,000 with shoulder guns alone becomes apparent. *What the condition of this country would be in a sudden emergency we can only guess. Judging from the experience of some of our ill-advised manufacturers who undertook to make shells, it would be of great confusion and enormous waste.*"

K. A. Juthe, in discussing the experience of American manufacturers in the production of rifles for foreign governments, stated that the gage problem was one of the greatest magnitude, as it was found that it would take at least 300 first-class gage makers to furnish the first working set, inspector's set, and the master set necessary for guns in quantities. And when 1000 complete rifles per day is figured on, it means that the working sets would be increased from one to ten, and the inspectors' sets from one to five, keeping the master set simply for reference. It was shown conclusively that among the total of practically 2500 to 3000 first-class gage makers in the country there was no adequate means of tackling several different propositions at the same time.

In regard to tool making, it was found that the jigs, fixtures and small tools required would take a small army of tool makers. It would take at least 1000 tool makers one year to furnish tools of this kind for the output of 1,000 rifles per day. Therefore, should our Government require, say, 500,000 or 1,000,000 rifles per year, our tool plants would be taxed to the utmost.

It appears, therefore, that what Representative Tilson stated in Congress did not disclose any military secrets, but as J. H. Brophy said at the meeting, "I am under the impression that it will take years of pounding away at the facts to enlighten the people on this great undertaking of Industrial Preparedness."

The way the situation has worked out, as announced by the General Munitions Board on May 15, is that the British Enfield rifle, chambered for regulation U. S. Army cartridges, will be used for our troops; and field guns of tried foreign types, but of American manufacture, will be introduced into the service. Manufacturing facilities for the Springfield rifle are not adequate to supply the number of rifles required for the force which the United States will raise and to replace the wastage of such a force. Fortunately the existing small-arms factories which have been turning out quantities of rifles for the British army are equipped to manufacture the Enfield rifle in more than sufficient number.

Engineering Committee of National Research Council

THE first meeting of the Engineering Committee of the National Research Council was held on May 3 in the rooms of the National Advisory Committee for Aeronautics, Munsey Building, Washington, D. C., with Gano Dunn, Mem. Am.Soc.M.E., as Chairman. There were in attendance the following members of The American Society of Mechanical Engineers: Gano Dunn (Chairman), John A. Brashear, Wm. F. Durand, John R. Freeman, Hollis Godfrey, George E. Hale, F. H. Newell, S. W. Stratton, Ambrose Swasey, and Charles D. Young.

Mr. Dunn explained the necessity for coöperating with the engineering societies and for fixing the relations between the Engineering Committee of the National Research Council and the Committee on Science and Research of the Advisory Commission of the Council of National Defense, of which Dr. Hollis Godfrey is chairman. The scope of the work of the Engineering Committee as explained by the chairman is to be engineering incidental to research work and not original engineering work unconnected with research, although it was pointed out at the same time that the line of demarcation between these two fields is not very clear.

Dr. F. H. Newell then spoke of the work of the Institute for Government Research. This institute is financed privately and the work is conducted solely for the purpose of helping the Government to simplify its procedure and hence to economize, and its work has the active sympathy of the Council of National Defense and the National Research Council.

Dr. George E. Hale spoke generally of the relations of the National Research Council to other organizations engaged in national defense, in working out certain problems of great importance, the first of which was protection against torpedo attacks.

As regards the matter of the organization of the Engineering Committee the meeting adopted the suggestion of John R. Freeman, to the effect that a single head of the Engineering Committee resident in Washington should be appointed and confer with the other members of the committee and with the members of the National Research Council in Washington. Wm. F. Durand was appointed Washington head of the Engineering Committee—to be known as Vice-Chairman of the committee, with Mr. Dunn remaining as Chairman.

The matter of dealing with inventions next came up for discussion, i.e., whether inventions should be referred to the Naval Consulting Board or the Engineering Committee should undertake to pass upon them. After considerable discussion the matter was left to be determined by the Engineering Committee, but the consensus of opinion was that when it is a question of passing on an invention without relation to any other aspects of the matter, it should be referred to the Naval Consulting Board. In other cases the Engineering Committee should consider the matter.

It was generally agreed that as much publicity as possible should be given to the needs of the Government in the solution of its engineering problems by the engineering societies, with the understanding, however, that there are certain matters which cannot properly be made public.

At the conclusion of the meeting Dr. Godfrey spoke at length with regard to the relations of his Committee on Science and Research of the Council of National Defense to the National Research Council; but explicitly disclaimed any intention of doing research work or of passing upon research work in his committee, and stated that all research work, whether engineering or scientific, would be referred directly to the National Research Council.

New Equipment on the Lehigh Valley

THE general tendency in American railroad equipment to use heavier and bigger tractive units is well exemplified by the recent steps taken by the Lehigh Valley. This railroad succeeded in materially reducing its train-miles in freight service on several divisions by the use of powerful Pacific type and 2-10-2-type locomotives built by the Baldwin Locomotive Works.

By the use of the Pacific-type locomotives between Manchester, N. Y., and Coxton, Pa., a distance of 175 miles, two fast freight trains which were previously hauled by heavy 10-wheel locomotives having a tractive effort of 31,000 lb. have been consolidated. This achievement is all the more significant as the stretch is by no means an easy one. From Coxton to Summit, N. Y., about 120 miles, there is a steady upgrade with many curves, the gradient running as high as 0.4 per cent.

On the Wyoming Division, between Pittston and Athens, Pa., the Pacific-type locomotives are also used for heavy express passenger traffic. These locomotives are among the most powerful of their type, with a tractive effort of 48,700 lb., or more than twice as much as the tractive effort of the 10-wheel locomotives which they replace. While in many respects they resemble the latest design of the Lehigh Valley Mikado locomotives they differ from the greater part of the motive-power equipment on the Lehigh Valley in that they are designed for burning bituminous coal.

The 2-10-2-type locomotives are used in slow freight service between Manchester, N. Y., and Sayre, Pa., a distance of 88 miles, with 0.4 per cent grades. Each of these locomotives will haul 4000 tons and make the 88-mile run in 6½ hours, thus replacing two heavy consolidation locomotives. They burn a mixture of fine anthracite and soft coal.

The boilers for both of these types have a conical ring in the middle course by which the diameter is increased from 83¾ in. to 94⅞ in. The seam of the smokebox ring is welded along the top center line of the boiler. All the seams in the firebox, including those in the combustion chamber, are welded. The side and crown sheets are in one piece, being ⅜ in. thick; the door sheet is likewise ⅜ in. thick.

In both types of these locomotives the reciprocating parts are of special steel to reduce their weight. The piston heads are made of rolled steel of light section, 1 in. thick at the piston-rod hub and 11/16 in. thick at the outside of the web. Hunt-Spiller bull rings are held in place on the piston head by a retaining ring which is welded to the piston head. The packing rings are also of Hunt-Spiller metal. All extended piston rods are of Mikrome steel.

The crankpins, connecting rods, stop straps and extended piston rods are made of Mikrome steel. The piston rods are held in the piston head by a single nut provided with a nut lock made from a disk 5/16 in. thick in the body and ⅛ in. thick at the circumference. After the nut has been drawn up tight this disk is cut and bent over on to the faces of the nut. These nut locks are made of dead-soft steel and are used only once.

For the foregoing information credit is here given to *The Railway Mechanical Engineer*, May 19, 1917, pp. 231-234 (vol. 91, no. 5).

National Advisory Committee for Aeronautics

FROM a letter from the Committee dated April 27, 1917, is taken the following information supplementary to the article describing its constitution and activities in the May issue of THE JOURNAL (p. 454). This covers all information to date, of which some was not available at the time when the May issue went to press.

To facilitate the work of the Committee the following subcommittees have been established:

Aerial Mail Service, Brigadier General George O. Squier, U. S. A., Chairman.

Aero Torpedoes, Lieut. J. H. Towers, U. S. N., Chairman.

Aircraft Communications, Dr. Michael I. Pupin, Chairman.
Airplane Mapping Committee, Brigadier General George O. Squier, U. S. A., Chairman.
Bibliography of Aeronautics, Prof. Charles F. Marvin, Chairman.
Design, Construction and Navigation of Aircraft, Brigadier General George O. Squier, U. S. A., Chairman.
Governmental Relations, Dr. Charles D. Walcott, Chairman.
Nomenclature for Aeronautics, Dr. Joseph S. Ames, Chairman.
Patents, Dr. Charles D. Walcott, Chairman.
Physics of the Air, Prof. Charles F. Marvin, Chairman.
Power Plants, Dr. S. W. Stratton, Mem. Am.Soc.M.E., Chairman.
Relation of the Atmosphere to Aeronauties, Prof. Charles F. Marvin, Chairman.
Standardization and Investigation of Materials, Dr. S. W. Stratton, Mem. Am.Soc.M.E., Chairman.
Foreign Representatives, Dr. Charles D. Walcott, Chairman.

The Second Annual Report of the Committee has just been issued and copies may be had on application to the Committee. This publication contains reports on the following subjects:

General Specifications Covering Requirements of Aeronautic Instruments
Nomenclature for Aeronautics
Mufflers for Aeronautic Engines
Gasoline Carburetor Design
Experimental Researches on the Resistance of Air.

The Committee has also investigated the facilities available in various colleges, technical and engineering institutions, and among manufacturers and aeronautical societies, for carrying on special investigations.

At the present time the Committee is proceeding with the establishment of a field experimental station, near Hampton, Va., for the scientific study of aeronautical problems.

The Committee expects to have a testing laboratory, wind tunnel, and machine shop, and specifications for the necessary buildings are being prepared. The operations of the Committee will be in conjunction with the Army and Navy.

An investigation of air propellers, under the direction of the Chairman, Dr. Wm. F. Durand, Mem.Am.Soc.M.E., is being conducted at the Leland Stanford Jr. University, and a special wind tunnel has been installed there in connection with this work. It is expected that the results of this investigation will appear in the Third Annual Report of the Committee.

Work now being carried on at the Bureau of Standards comprises the testing of aeronautical materials, spark-plug investigations, and the study of carburetor design.

The patent situation in the aeronautical industry, which appeared to threaten its development, is in a fair way of being cleared up satisfactorily to all concerned, as a result of the interest taken in this matter by the Committeee.

The Committee will directly attack the more important problems of aeronauties as soon as its field experimental station is established.

If an examination of the ordinary hacksaw machine is made, it will be found that often the slides of the saw frame are narrow and do not have any convenient and durable method of maintaining alignment. The device for maintaining saw tension often is weak and cannot be locked to prevent loosening while the saw is in operation. These two features are important because unless the machine is well designed saw breakage will be excessive.

This Month's Abstracts

THE relation of horsepower to weight in an automobile and conditions affecting the output of same is discussed in an abstract of an article by A. Ludlow Clayden. Among other things, the writer points out the tempting ease with which fake power curves can be obtained, and touches in an interesting manner upon multi-valve engine design.

The relation between the chemical constitution and grain structure of bearing bronzes on one hand and their mechanical properties on the other is discussed in an article abstracted from the *Iron Age*. The writers claim that by scientific and skillful foundry methods a bronze containing lead may be produced without an impairment of its mechanical strength.

The tendency towards elimination of wastes is well illustrated in two articles on practically the same subject: one by Prof. J. W. Cobb, on The Utilization of Low-Grade Fuels, taken from an English publication; and the other on Coke Braize and Its Utilization, by W. A. Hamor, from *Coal Age*. These two articles show that economic burning of fuels, which until quite recently have been entirely wasted, may be considered an accomplished fact.

Wm. J. Leenhouts, from data secured in the Laboratory of the University of North Dakota, attempts to establish the basis for a scientific specification of gasoline. He rejects the gravity test, but considers volatility as the basic property of gasoline. At the same time he makes clear that with modern carburetors, products having a wide range of boiling points may often be economically burned. It is therefore suggested that if any specification be adopted by the Government, it should cover only the application of the name "gasoline" to a particular fuel, but should not restrict the sale of other fuels if marketed as "motor fuels" simply.

The application of regenerative principle to the design of gas furnaces is discussed in an article by W. C. Buell, Jr. Among other things, a graphic comparison of temperatures in the various parts of recuperative and non-recuperative types of gas-oven furnaces is given.

From the *Electrical World* is abstracted the description of the Montague City Station of the Turner's Falls Power and Electric Company, a large plant with a proposed output of 36,000 kw. Special attention is called to the enumeration of measuring and recording instruments used and the description of precautions taken against the spread of transformer fires.

In the section Measurements are given advance abstracts of three papers to be published by the Bureau of Standards, furnished to THE JOURNAL by courtesy of the Director of the Bureau.

The McClellon water-tube firebox is described and illustrated in the section Railroad Engineering, where will also be found an abstract of an investigation carried out at the University of Illinois on the resistance of passenger cars.

The deterioration of Curtis-Rateau turbine blading forms the subject of a paper presented by A. Fenwick to the South African Institution of Engineers and abstracted in the section Steam Engineering. An interesting part of this investigation is that referring to the use of aluminum bronze, which was found to be very satisfactory in the low-temperature stages, but entirely unsuited for the high-temperature stages. Attention is also called to the improved inlet nozzle, in which the cutting out of a portion of the vane eliminated troublesome breakage.

From a discussion of a paper on the Burning of Blast Furnace Gas Under Boilers, before the Engineers' Society of Western Pennsylvania, are abstracted data on the aspirating characteristics of various burners.

REVIEW OF ENGINEERING PERIODICALS

SUBJECTS OF THIS MONTH'S ABSTRACTS

Horsepower Facts and Fallacies.
Fake Power Curves of Automobile Engines.
Multi-Valve Automobile Engines.
Breathing Capacity of Engines.
Bearing Bronzes, Structure and Mechanical Properties.
Lead in Bearing Bronzes.
Utilization in Low-Grade Fuels.
Bettington Boiler.
Coal Dust in Gas Producers.
Coxe Traveling Grate for Burning Coke Braize.
Parsons Distributor for Burning Coke Braize.
Gasoline Specifications.
Combustion in the Fuel Bed.
Recuperative Gas-Oven Furnaces.
Montague City Hydroelectric Plant.
Isolation of Transformer Fires.
Effusion Method of Determining Gas Density.
Relative Sensibility of the Average Eye to Light of Different Colors.
Aneroid Calorimeter for Specific and Latent Heats.
Mallet Articulated Locomotives, P. & R. RR.
McClellon Water-Tube Firebox.
Resistance of Passenger Cars.
Deterioration of Curtis-Rateau Turbine Blading.
Aluminum Bronze Blades.
High and Low Nickel-Steel Blades.
Inlet Nozzles for Steam Turbines.
Burning Blast Furnace Gas under Boilers.
Hydraulic Test of Pipe Connections.
Air Drying for Blast Furnaces.
Tests of Heat-Insulating Materials.
Translation of Formulae.
Hours, Fatigue and Health in British Munition Factories.

Automobiles

Horsepower Facts and Fallacies, A. Ludlow Clayden

Discussion of the relation of horsepower to weight in an automobile, horsepower curves and conditions affecting output.

There is a limit to the power which can be used in an automobile, this being the amount of driving effort that can be exerted without causing the wheels to slip, which again is a function of the weight on the driving wheels. Actually, however, as the writer shows, the horsepower developed is rather below one-half of what the respective cars could transmit, providing the usually assumed coefficient of friction between the tire and road is correct.

The writer disagrees with the statement made that the steam engine is nearer the ideal for automobile use than the gas engine. While in the steam engine the power output is more constant than in the gas engine, what is particularly desirable in a car is constant tractive effort, and this is no more easily obtainable with steam than with gasoline.

As regards this latter, Fig. 1 shows curves of tractive effort per 1000 lb. of car weight plotted against speed for some cars of different types, fours, sixes, eights and twelves, of good makes. It is immediately noticeable that the best performance of any gives an effort under 16 lb. at the best speed compared with 25 lb., which is theoretically possible. The six or seven designers have apparently aimed at the best torque at low speed, leaving the high speed to take care of itself. The great difference in the shape of the curves is also very striking, especially as the curves from which these illustrations were made, had been submitted to the writer confidentially, and are, therefore, rather more accurate than the general run of "publicity" curves. None the less, there is some suspicion that the curves are not entirely reliable throughout their length.

In this connection the writer calls attention to the possibility of faking up power curves. An imaginary example of such a curve is shown in Fig. 2. The lower curve is probably obtained from the stock engine in normal condition, and then the upper curve obtained by tuning it up. Now, the normal condition curve is fairly accurate, and so is the tuned-up curve *above a certain speed*. But the upper curve cannot possibly coincide with the lower curve over the slow-speed range as shown in the illustration, and the departure from the truth is caused by drawing a good-looking straight line downward from the last observation (this is still more clearly brought out in the following paragraph).

Among other things the article discusses in an interesting manner the question of multi-valve engines. Fig. 3 gives a comparison of two curves made from the same engine with carburetors of similar design but different sizes. The better high-speed curve fairly coincides with the lower one at 800 r.p.m., and here the better curve really ends. With the larger carburetor, steady pulling at 700 r.p.m., with full throttle, was possible, but was not reliable. With a smaller instrument full-throttle operation down to 400 r.p.m. was certain, but at the

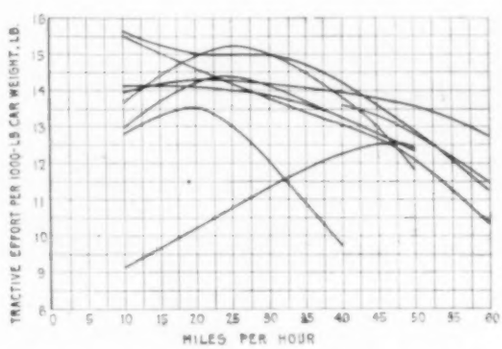


Fig. 1 Diagrams of Tractive Effort in Pounds per 1000 lb. of Car Weight Plotted Against Road Speeds from 10 to 60 m.p.h.

expense of loss of power at from 1500 r.p.m. up. Here one can see how easy it is to make a misleading curve. From having investigated the range from 800 to 2000 r.p.m. on the large carburetor, we should have a beautiful straight-line power curve, which looks just as though it would continue down to about 100 r.p.m.; but it does not.

The most interesting thing about these tests is, however, that even the largest carburetor used was far smaller than the "breathing capacity" of the engine. Hence, even with the largest carburetor, it would probably be found that, while the maximum power might be raised 20 per cent by using the full breathing capacity of the engine, it would not be possible to use full throttle below 1000 r.p.m., corresponding to about 25 m.p.h. with normal gearing. This brings the writer to the conclusion that increasing the valve size or lift, or using more than two valves per cylinder, would not help the power curve *throughout* the range of normal operation.

What the author thinks, however, is that the problem could

be solved in a different way: namely, by leaving the power the same and cutting the weight of the car 40 per cent. This cannot be done at present, but the knowledge gained in light-engine building from aviation work holds out a great promise for the future. (*The Automobile*, vol. 36, no. 17, April 26, 1917, pp. 820-824, 8 figs., *et*)

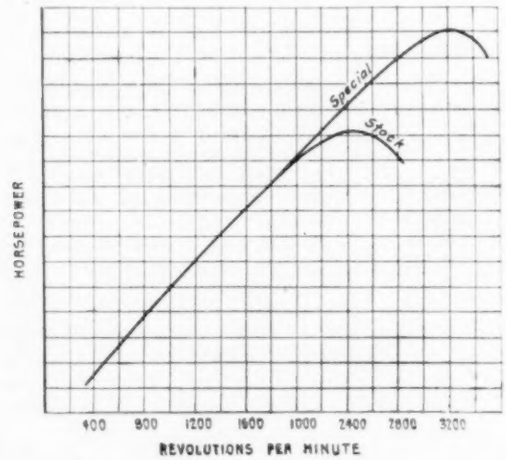


FIG. 2 AN IMAGINARY EXAMPLE OF FAKE POWER-CURVE DRAWING

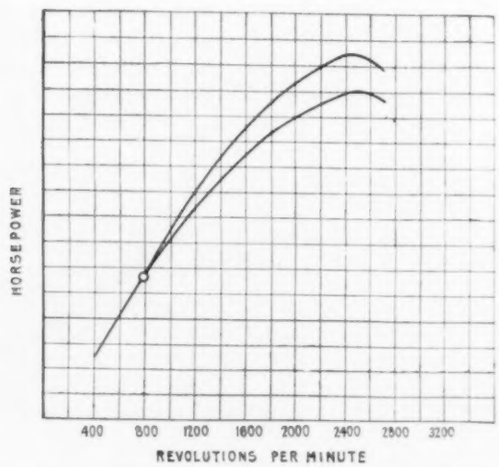


FIG. 3 ACTUAL CURVES MADE FROM THE SAME ENGINE, BUT WITH DIFFERENT-SIZED CARBURETORS OF THE SAME MAKE

Statements that operation on kerosene as compared with gasoline gives a greater mileage per gallon if carburetion and compression are properly cared for, seem to be borne out by a recent A. A. A. test of a new system for using kerosene in which a distance of 25.5 miles per gallon was run on kerosene as against 23.0 m.p.g. of gasoline with a Ford car and stock carburetor.

This test was under sanction of the American Automobile Association and under the supervision of E. A. Hillman, representative of the A. A. A. contest board for this territory, Chicago. With the same setting of the carburetor at which the economy test was made, an acceleration from 10 to 15 m.p.h. was made in 15.6 sec. With that adjustment the car idled down to 10 m.p.h., but with a richer adjustment its running was good at 4 m.p.h. The car had been in service since last fall.

Engineering Materials

BEARING BRONZES AND THE MICROSCOPE, C. H. Bierbaum, Mem.Am.Soc.M.E., and Verne Skillman

Discussion of the relation between the chemical constitution and grain structure of bearing bronzes on one hand, and their mechanical strength in various respects on the other hand, and also discussion of the influence of lead on the properties of bearing bronzes.

In this case three bronzes were investigated. Two of these were found to be almost identical in chemical composition, but under tension test one was more than 50 per cent stronger than the other. This was explained when photomicrographs of these bronzes were taken. These photomicrographs are reproduced in Fig. 4, and show that apparently the lower tensile strength of bronze *A* was due to improper metallurgy and defective foundry practice in its production.

TABLE 1 CHEMICAL ANALYSIS AND MECHANICAL PROPERTIES OF THREE BEARING BRONZES

a Chemical Analysis

	Bronze *A* Per Cent	Bronze *B* Per Cent	Bronze *C* Per Cent
Copper	86.75	86.0	86.0
Tin	10.79	11.0	9.5
Lead	....	0.5	2.5
Zinc	2.40	2.5	2.0

b Mechanical Properties

	Bronze *A*	Bronze *B*	Bronze *C*
Elongation, per cent	1.5	8.0	6.0
Yield Point, lb per sq. in.	16,000	17,500	17,000
Tensile Strength, lb. per sq. in.	20,500	32,500	25,000

This would indicate the importance of making a microscopical examination in addition to chemical, physical and mechanical tests of metal alloys.

Another rather unexpected condition was found in two of these bronzes (*B* and *C*) whose principal difference in composition was that bronze *C* contained 2.5 per cent lead, while *B* contained none. The bearing value of lead in bronzes is well known, and it is also supposed that it weakens the metal. It has, therefore, always been a matter of compromise in the making of leaded bronzes as to how much strength should be sacrificed for a gain in bearing qualities. But if the strength of a bronze can be increased by scientific and skilful foundry methods, the bearing value of that bronze can be greatly increased by the presence of lead. This is claimed to have been done in the production of bronze *C*, where the presence of lead, while enhancing its bearing value, does not prevent it from having a higher strength than bronze *A* which contains no lead (cp. analysis in Table 1).

The two tables reproduced as *a* and *b*, Table 1, are of interest in that they give a basis for a comparison between the chemical composition and mechanical properties of the three bronzes above referred to. (*Iron Age*, vol. 90, no. 16, April 19, 1917, pp. 946 and 947, *d*)

Firing and Fuels

THE UTILIZATION OF LOW-GRADE FUELS, Prof. J. W. Cobb

Discussion of various methods of using very small fuel or dust. The difficulty of burning such fuel under a boiler is that a bed of it acts like a large sandlute, which acts, in its turn, as a gas sieve. The resistance of the numerous but minute channels through the fuel is so very high that, although the structure is quite porous, no reasonable pressure will drive any considerable quantity of air through it; while excessively raising the pressure results in the lute "blowing" in weak places.

In this connection, the writer describes the Bettington boiler, in which a blast of air carries the coal from a separator, through a fine sieve, to the bottom of a vertical water-tube boiler, and the mixed blast burns as a huge jet through a water-cooled nozzle vertically into the combustion chamber. The time which a particle, in passing through a boiler of this kind, can spend in the combustion chamber is remarkably small and therefore the combustion itself is usually somewhat incomplete.

Attempts have also been made to gasify coal in an air-dust stream, which only carries oxygen enough for the purpose of gasification, leaving the completion of combustion to be effected by a secondary air supply either in a furnace or in an internal-combustion engine. In other words, the dust system has been attempted with a measure of success for the manufacture of producer gas; e.g., by Marconnet. In this producer a fine fuel is fed into a hopper, from which it falls on a revolving plate driven by a friction wheel. From this plate a small scraper feeds a fine rain of coal by way of a sloping plate to a fan which carries the air thus charged with particles of coal to the producer. The speed of the fan determines that of the revolving plate and therefore the supply of coal varies automatically with that of the air. The air-dust stream enters tangentially at the bottom of the producer, while the gas leaves at the top.

Considerable quantities of dust coke have been effectively disposed of in Mond gas producers in England. Further experiments have also come to the attention of the writer in which very fine fuel was gasified with some measure of success by mixing with an equal proportion of breeze from a puddling furnace.

From this the writer passes to a brief consideration of the use of low-grade fuel in the form of briquets, and finally to a method of treating coal proposed by Bergius and consisting essentially in heating coal to fairly high temperatures (300 to 400 deg. cent.) in an atmosphere of hydrogen maintained under very high pressure. (*The Iron and Coal Trades Review*, vol. 94, no. 2,563, April 13, 1917, p. 410, *gd.*)

COKE BRAIZE AND ITS UTILIZATION, W. A. Hamor

In by-product coke-oven practice it is customary to call braize, or breeze, that portion of coke which passes through a screen having ½-in. square openings. The calorific power of dry braize approximates 12,500 B.t.u. per lb., so that it is actually a fairly high-grade fuel. It is, however, difficult to burn by ordinary means, and the use of forced draft is essential to its proper utilization.

Recently, however, combustion appliances have been developed for its utilization and several types of equipment originally designed for the combustion of anthracite culm have been found readily adaptable to the burning of coke braize.

In this connection, the writer describes in detail the Coxe traveling grate, which is now being successfully operated with coke braize in several plants (Fig. 5).

In this grate the fuel-supporting surface is made up of keys called grate tops, which are small castings approximately ¾ in. wide, 9 in. long, and 2 in. deep. The top surface is curved and the front end of each key matches the rear end of the next key.

The stoker shafts are of cold-rolled steel and each shaft carries keyed to it two cast-iron sprockets located just inside of the side frames. Cast-iron flanges project inward from the side frames. To these flanges are bolted sheet-steel plates, forming a floor between the side frames about 10 in. from the bottom thereof, with vertical air baffles at each end of the stoker. On top of the floor are built two air boxes, or tuyere boxes, extending across the stoker between the side frames and communicating, on one end through rectangular openings, with one side frame with the air connections from the forced-draft air duct.

It is recommended that the air for combustion be supplied at a static pressure of 2 to 2½ in. of water. The fuel is fed to a hopper extending across the front end of the stoker above the grate from which it is deposited on the grate, the thickness of the fuel on the grate being regulated by the adjustable coal gate. There are three or four air compartments each extending crosswise in the furnace, and in each of

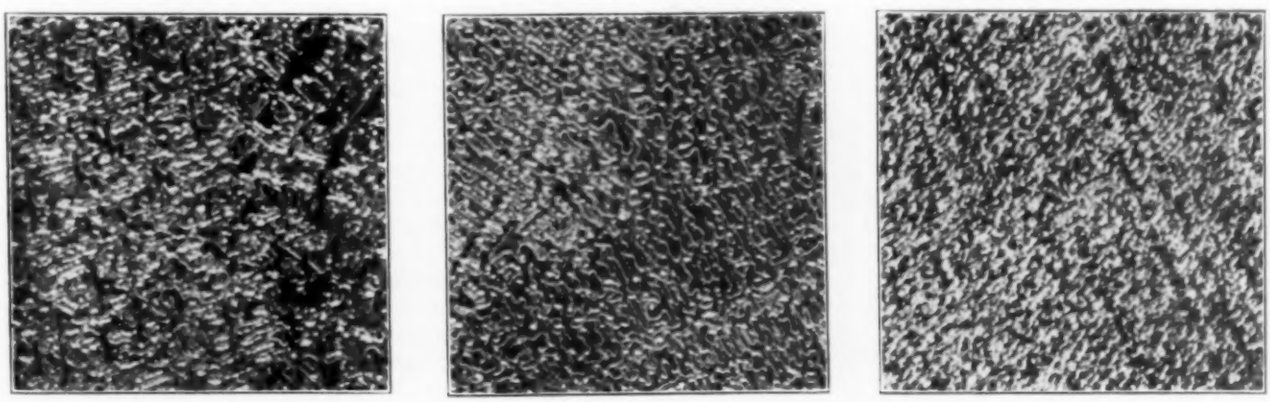


FIG. 4 PHOTOMICROGRAPHS OF BRONZES *A*, *B*, AND *C* (REDUCED ABOUT ONE-THIRD FROM THE ORIGINAL MAGNIFICATION OF 50 DIAMETERS) ETCHED WITH FERRIC CHLORIDE

these the air pressure may be independently regulated. It is thus possible to vary the rate of combustion over each air compartment as desired.

The three compartments may for convenience be called the ignition, combustion, and burning-out compartments; the function of these compartments being to enable the operation to vary the pressure under the grate in accordance with the thickness of fuel immediately above that section.

Under regular operating conditions in connection with a 500-hp. boiler, one of these stokers is stated to develop from 150 to 200 per cent of boiler rating with efficiencies ranging from 65 to 70 per cent.

The Parsons distributor has also been successfully used for burning coke braize. It consists of a steam-driven injector blower, which intermittently draws gas from the boiler furnace and projects it at high velocity against a small portion of the fuel which is simultaneously delivered into the path of the gas by a reciprocating pusher. A test (by C. J. Bacon, Mem.Am.Soc.M.E.) showed the efficiency and capacity of the

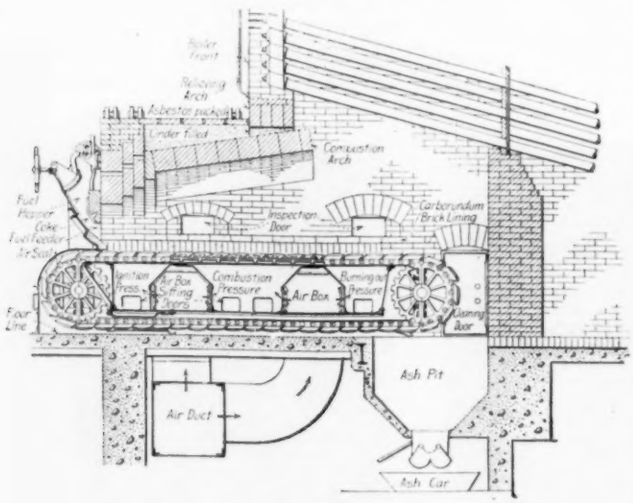


FIG. 5 SECTION OF COKE GRATE AND SETTING

distributor to be nearly the same with coke-dust as with coal. (*Coal Age*, vol. 11, no. 18, May 5, 1917, pp. 780-782, 2 figs., *d.*)

GASOLINE SUPPLY AND ITS RELATION TO SPECIFICATIONS, Wm. J. Leenhouts

Discussion of the supply of gasoline and its relation to consumption, the properties of modern gasolines and the bases of possible specifications.

Like every one else, the writer points out the probable inability of the present supplies of gasoline to hold out if the present rate and tendencies of consumption continue. He likewise points out that the great demand for gasoline has changed its quality very much. From year to year the residue in the gasoline has increased, which means that a larger portion of kerosene is being added continuously. The mixture of kerosene with gasoline does not, however, necessarily mean a poor motor fuel, as this depends on the amount and the portion of the kerosene range used in the mixing.

On the other hand, the claims made by many refiners for the superior power-producing qualities of their gasolines are largely without foundation. Automobile owners who have cars of suitable construction and necessary adjustments can get as good results out of cheap gasoline as out of expensive "high-test" product.

The problem of making a gasoline specification by legislation is not an easy one. The first question is what the specification shall be based on. The gravity test has been discarded by Director Manning of the Bureau of Mines. The investigations of the present writer show also that the gravity test may be entirely misleading. In the Petroleum Laboratory of the University of North Dakota there are two gasolines whose boiling range is nearly parallel and similar, but whose gravities are 49 and 55.5 deg. B. respectively. Further, the writer compares a gasoline of 49 deg. B. with the kerosene of the same gravity, and finds a difference of over 100 deg. in their initial boiling points, and a difference of 200 deg. in their end points. Because of this difference in the gravity for gasolines of a given volatility, gravity has been discarded as a criterion for rating a gasoline.

The basic property which determines a gasoline is volatility, or range of its boiling points. It is desirable to have a certain percentage of fairly-low-boiling constituents, so that engines may start more readily, but a large proportion would be undesirable because of loss through evaporation, and accidental ignition or explosion. A reasonable amount would probably be about 3.5 per cent at 158 deg. fahr. At the University Laboratory the average percentage of distillate at 158 deg. fahr. of all low-grade gasolines analyzed was 3.4 per cent for the year 1916 and 3.6 per cent for the year 1915. Again, a reasonably low end point is desirable in order to insure complete vaporization, but it makes an expensive gasoline. The average end point of low-grade gasoline is approximately 375 deg. fahr., with a residue of 37.5 per cent at 284 deg. fahr. The average end point for 1916 of all low-grade gasolines analyzed was 377 deg. fahr. and the percentage residue at 284 deg. fahr. was 37.6.

The grade of a gasoline is a variable factor when it comes to types of cars and their ages. Cars built three or four years ago were built for gasoline sold at that time, while a more modern car has a carburetor which can work efficiently with rather low-grade gasolines as put on the market to-day.

Hence, specifications, if made, must be broad enough so as not to exclude any type of gasoline from being sold.

The author suggests that perhaps specifications should cover only products sold under the name of *gasoline*, while all other products might be sold as *motor fuels*. Further, he suggests that any motor fuel might be placed on the market, but that it be labelled as to its 20 per cent and 90 per cent distillation temperatures, so that the purchaser would know the degree of volatility of the fuel he is buying.

If specifications are made, they should not be rigid and reduce the quantity of gasoline produced from a gallon of crude, nor should they in any way work against conservation of natural petroleum resources, and against the development of the petroleum industry.

In summarizing, the desirable properties of a gasoline are stated as follows:

1 Gasoline should not give a disagreeable odor before or on combustion. This is objectionable to users of automobiles and shows poor refining.
2 It should be free from matter not hydrocarbon, such as water, sediment, acid and sulphur. Acid and sulphur have a tendency to act upon the metal parts of an engine.
3 It should not contain excessive percentages of unsaturated

hydrocarbons because they have a greater tendency to carbonize.

4 It should not contain too large a percentage of volatile products because of loss through evaporation and danger of accidental ignition and explosion.

5 It should not contain a high percentage of heavy products which will not volatilize.

These are the requirements for a good gasoline. It still remains to fix the limits to these requirements. (*The Quarterly Journal of the University of North Dakota*, vol. 7, no. 3, April 1917, pages 251-260, 8 figs., *g*)

COMBUSTION IN THE FUEL BED OF HAND-FIRED FURNACES, Henry Kreisinger (Mem.Am.Soc.M.E.), F. K. Ovitz and C. E. Augustine

The main object of the investigation was to determine the conditions governing the process of combustion in the fuel bed in a hand-fired furnace. The results furnished data for correct design of coal-burning grates and furnaces and their efficient operation. They also cast light on the problem of clinker trouble as related to fusibility of ash, and indicated the possibility of a high rate of gasification of coal in gas producers.

The paper describes in detail the method of carrying out the tests and making various measurements involved, and presents the results in the form of tables and curves.

Among other things these tests indicate that with the 6-in. bed of Pittsburgh or anthracite coal the oxygen is all used up in combustion at a distance of 3 to 4½ in. above the grate. The CO_2 content reaches a maximum of about 15 per cent at a distance of 2 to 3 in. above the grate, and then decreases until, at the surface of the fuel bed, it is 7 to 10 per cent. At the surface of the fuel bed there is 20 to 32 per cent of combustible in the gases and practically no oxygen, but the percentage of the combustible in the gases increases rapidly beyond 3 in. above the grate.

With 12 in. beds of all three fuels tested and with the 6 in. bed of coke all of the oxygen disappears 4½ to 6 in. above the grate. But in all tests there was at the surface of the fuel bed a large percentage of combustible in the gas and no oxygen to burn it, showing that the fuel bed of any hand-fired furnace acts primarily as a gas producer. In many tests the gas at the surface of the fuel bed would be considered a fairly good grade of producer gas.

It was found that at the surface of the fuel bed and 1½ in. above it, the gases contained more oxygen, more CO_2 and less combustible than 1½ in. below the surface. This change in the composition of the gases was caused by air reaching the surface of the fuel bed from above, along the walls of the furnace, as shown in Fig. 6.

The effect of this downflow of air was much more marked with low rates of combustion than with high rates, because with a high rate the large volume of gases leaving the fuel bed more nearly filled the space above it and prevented the air from flowing down.

The fact that with coke the oxygen does not disappear as quickly as with the Pittsburgh and anthracite coal, is ascribed to the higher percentage of ash in coke and its uniform distribution through the combustible.

THE THREE COMBUSTION PROCESSES

The writers believe that combustion in the fuel bed consists mainly of three processes; namely, the oxidation of carbon to CO_2, the reduction of CO_2 to CO, and the distillation of volatile matter, this latter being of great importance with bituminous coal. The combustion is the result of contact of two streams, air flowing up through the grate and fuel which is fed from the top and gradually sinks toward the grate. At the bottom the air contains 21 per cent of oxygen and the fuel bed but little combustible; at the top of the fuel bed there is practically no oxygen and a high percentage of combustible.

The rate of oxidation of the lower part of the fuel bed depends almost entirely on the rate at which air flows through it. Next comes the reducing zone, in which the rate of reduction of CO_2 to CO depends on the temperature of the fuel bed and, up to a certain limit, on the length of time that the CO_2 is in contact with the hot carbon. The limit of reduction is the equilibrium between CO_2, CO and carbon at the temperature existing in the fuel bed, but at the high temperature which actually exists there the reduction of CO_2 to CO is a rapid process.

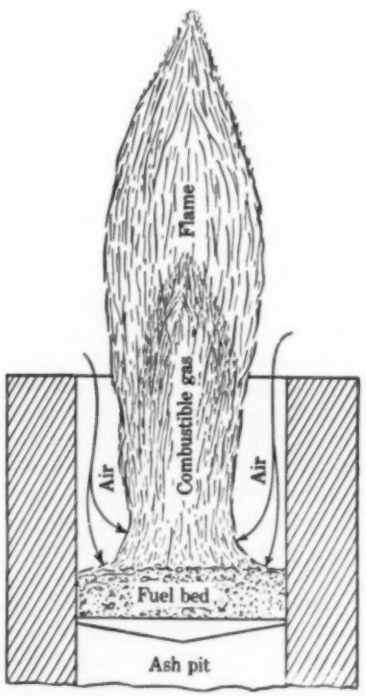


FIG. 6 DIAGRAM INDICATING THE FLOW OF AIR TO THE SURFACE OF FUEL BED FROM TOP OF FURNACE (DISTINCTLY NOTICEABLE AT LOW RATES OF COMBUSTION)

The layer at the top of the fuel bed, consisting mostly of fresh fuel, is the distillation zone. It overlaps the reduction area and extends about 2 in. below the surface of the fuel bed. There is, however, no sharp line of demarcation between the three zones, and particularly between the reduction and distillation zones. The rate of distillation depends on the rate of heating of the coal, which again depends on the temperature in the furnace, but with a given temperature the distillation is independent of the air supply, since when coal is heated the volatile matter distills off whether air is supplied or not.

Part of the combustible leaves the fuel bed in the form of soot, tar and cinders. The weight of soot and tar has been determined on eight tests with Pittsburgh coal, and comprises, roughly, about one-quarter of the combustible rising from the fuel bed. This quarter of the combustible is in a form which is difficult to burn in the combustion space, and if no provision

for its combustion is made, a large part of it may go out of the chimney in the form of black smoke. It appears that smoke is formed near the surface of the fuel bed and goes out of the chimney because the air supply is inadequate for its combustion. It is also possible that a large part of the volatile matter leaves the coal as tar, which immediately begins to break down into gaseous hydrocarbons and soot.

As regards the temperatures in the different layers of the fuel beds, it appears that the temperature is highest between the oxidizing and the reducing zone, approximately at the point of maximum CO_2 content in the gases. Further away from the grate in the reducing zone the temperature gradually drops, which is due to the reduction of CO_2, a heat-absorbing process.

Within wide limits the rate of feeding air has practically no effect on the composition of gases within the fuel bed, but affects directly the rate of combustion. In other words, if the rate of air forced through the fuel bed in a given time be doubled, the rate of combustion of the fuel is doubled, but the *weight of air forced through the fuel bed per pound of fuel burned or gasified is constant.*

For complete combustion air must be added over the fuel bed as the gases rising from the fuel bed contain a high percentage of combustible and no free oxygen, and this deficiency cannot be remedied by increasing the rate of air supply through the fuel bed.

Forced-draft apparatus cannot, however, supply enough air through the level fuel bed to insure complete combustion, and additional air must always be introduced over the fire in such a manner that it will mix with the combustible gases; otherwise a large percentage of them will escape unburned. The writers are careful, however, to emphasize that this does not make desirable admission of air through holes in fires and leaks in the furnace setting. The ideal way to supply additional air over the fuel bed is to introduce it as close to the fuel bed and in as large a number of small streams as possible. The nearer the air is introduced to the surface of the fuel bed, the more combustion space is utilized for mixing air with the combustible gases and for burning the mixture.

A thick fuel bed is undesirable because it increases the tendency of the coal to form troublesome clinker. Perhaps the only apparently defendable excuse for carrying a thick fuel bed is the fact that the chances of burning holes in the fuel bed are reduced. A skillful fireman avoids holes in the fuel bed by firing frequently and placing coal on the thin spots. A claim that fuel beds can not be kept in good condition if carried thin is a confession of neglect and lack of skill.

A fuel bed is understood to be only the layer of incandescent and freshly fired fuel, and does not include the layer of dead ashes and clinker on the grate.

The ash fuses in the upper layers of the fuel bed, and as it sinks it solidifies 2 to 4 in. from the grate. In most cases the fusion occurs in a reducing or partly reducing atmosphere, consequently in studying the fusibility of ash the determinations should be made in a partly reducing atmosphere.

As at the surface of the fuel bed the gases contain 20 to 32 per cent combustible gas and practically no free oxygen, to obtain complete combustion, additional air must be introduced over the fuel bed. This statement is true of all the fuels tested, including coke. As a general statement, about one-half of the 15 lb. of air used to burn 1 lb. of coal in a boiler furnace is supplied through the fuel bed; the other half must be supplied over the fuel bed. (*U. S. Bureau of Mines Technical Paper 137*, 1916, *et A*)

Furnaces

TESTS OF RECUPERATIVE GAS OVEN FURNACES, W. C. Buell, Jr

The regenerative-furnace principle has been applied to apparatus requiring high heat, such as open-hearth or glass furnaces, and has produced in addition to high flame temperature a material saving in fuel. To those operations in which close temperature limits are imperative, the regenerative principle cannot be applied directly, as the temperature of the heating chamber and the work of the regenerative furnace are highest just after the furnace is reversed. In fact, the pyrometer chart of the heating chamber of the regenerative furnaces resembles the edge of a saw, each sawtooth representing a reversal of the furnace.

The recuperative gas furnace described here has been designed primarily for the purpose of decreasing fuel costs. Of all the fuel used in a furnace from 25 per cent to frequently as much as 50 or 60 per cent is lost through the vent.

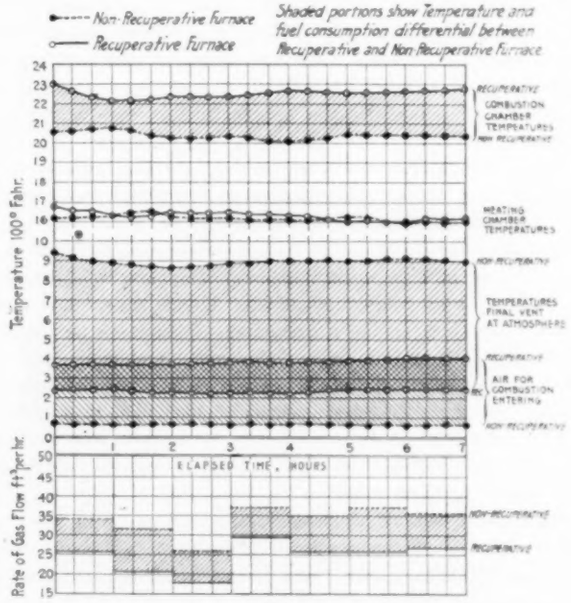

Non-Recuperative Furnace
Recuperative Furnace
Shaded portions show Temperature and fuel consumption differential between Recuperative and Non Recuperative Furnace
Temperature 100° Fahr.
RECUPERATIVE COMBUSTION CHAMBER TEMPERATURES
NON RECUPERATIVE
HEATING CHAMBER TEMPERATURES
TEMPERATURES FINAL VENT AT ATMOSPHERE
AIR FOR COMBUSTION ENTERING
ELAPSED TIME, HOURS
Rate of Gas Flow ft³ per hr.

FIG. 7 GRAPHIC COMPARISON OF TEMPERATURES OF THE COMBUSTION AND HEATING CHAMBERS, FINAL VENT TO ATMOSPHERE AND ENTERING AIR, AND THE GAS FLOW FOR RECUPERATIVE AND NON-RECUPERATIVE TYPES OF GAS OVEN FURNACES

Economy to be secured by the utilization of the waste heat at this point is quite great, and in addition a further saving in fuel may be secured by the increase in flame temperature of the fuel through its preheating.

The chart reproduced in Fig. 7 is said to be typical of test runs with a Tate-Jones recuperative oven furnace and a non-recuperative one of the same size. A balance sheet from the same furnaces is presented in the original article with figures covering an average hour of operation after the furnaces had reached an equilibrium at 1600 deg. fahr.

From this balance sheet it can be said that 28,920 B.t.u. were required to maintain this furnace temperature with a recuperating attachment, and 36,400 B.t.u. were required when no recuperator was used. With the recuperator there was returned in the air only 1712 B.t.u., which represents a fraction less than 6 per cent of the total B.t.u. used, but in spite of the fact that only this amount was returned in the air, a *net* saving in fuel was secured of approximately

20 per cent. The additional 14 per cent saving was secured by the increase in flame temperature.

The same table shows to what extent the flame temperature operates towards economy. Combustion-chamber radiation losses were, for example, 17,122 B.t.u. in the regenerative furnace and 19,200 in the non-regenerative furnace. The final vent loss into the atmosphere was 3700 B.t.u. from the recuperative furnace, and 10,250 B.t.u. from the furnace without recuperator. The chart shows the increase in the combustion-chamber temperature due to the increase in the flame temperature.

The article discusses also the conditions at the outlet of the recuperator as an indication of the low temperature of the gases leaving the vent and the improvement in working conditions surrounding the furnace. (*Iron Age*, vol. 99, no. 18, May 3, 1917, pp. 1082-1083, *dc*)

Hydroelectric Plant

MONTAGUE CITY STATION OF THE TURNER'S FALLS POWER AND ELECTRIC COMPANY

The new 36,000-kw. generating station of the Turner's Falls Power and Electric Company at Montague City, Mass., is the largest hydroelectric station thus far built in New England. It supplies energy to 66,000-volt lines extending from the Greenfield District to Springfield, Mass., and generally covers the low-distribution networks in the Middle Connecticut River Valley.

At present only four of the six units for which the station is designed are installed. The wheels are of the vertical single-runner type, rated at 9700 hp. each. Each wheel drives a 7500-kva. General Electric 6600-volt three-phase revolving-field alternator at a normal speed of 97.3 r.p.m., the system frequency being 60 cycles.

The governors are connected with the shafts by flexible-gear drive, which is claimed to eliminate the troubles sometimes arising from belting. Each generating unit has a lignum-vitæ guide bearing lubricated by water received from the scroll case through a Terry cloth filter.

Since operation began the company has installed a water-cooling coil in each thrust bearing consisting of 145 ft. of 1⅛-in. copper tubing per unit. Fifteen gallons of oil per minute are required to carry off the heat developed in each thrust bearing. The water for auxiliary cooling service can be taken either from the canal or from the municipal supply. The governor pumps are I. P. Morris horizontal centrifugal units rated at 325 gal. per min. each against a 525-ft. head, and are directly driven by 100-hp. induction motors. The sump tanks are installed in the pump pit and are cross-connected to a suction main from which the pump suctions are taken. The pumps discharge into a pressure main to which is connected a pair of accumulator tanks mounted on the operating-room floor, the governor-operating cylinders being fed from the pressure main, and discharging into a receiving main leading back to the sump tanks.

The guide and thrust bearings of the generating units are lubricated with ordinary machine oil supplied by gravity from a tank and filter located on a gallery, about 65 bbl. of oil being maintained in the system.

At each generating unit on the operating-room floor are located the governor with tachometer and gate-position indicator, the air-brake valve for controlling the rotor brakes, an engine-telegraph stand to connect with the switchboard gallery, a Peterson oil meter, one Schaeffer and Budenberg and three Peterson thermometers reading to 60 deg. cent. and connected with the oil piping, valves controlling the supply of oil and water to the generator bearings and governors, a Schaeffer and Budenberg recording thermometer on the thrust-bearing oil-discharge piping and a field-switch panel.

The following provisions have been made for isolating transformer fires. The transformers are located in a fireproof base on the east side of the operating room. All of the transformers are of the water-cooled type, with the circulating water furnished from the canal through the twin strainers and with an auxiliary town-water connection also available. The transformers are mounted on wheels, so that any unit can easily be removed by crane. Rolling firedoors, held open by fusible links, are provided for each transformer bay. Under the transformers are reinforced-concrete pits 18 in. deep which are connected with the river through traps for emergency oil discharge. The valve handle controlling this discharge is extended through the bay wall into the operating room to enable the oil to be discharged even when the firedoors are closed. Alarm devices are provided for indicating when the temperature of transformers exceeds 80 deg. cent., when the transformer cooling water is interrupted, when the governor-system water supply is too high or too low, when the bearing-oil supply is too high or too low, when the thrust bearings overheat and when the guide-bearing lubrication is interrupted.

Hourly readings are taken on the floor at each generating unit of the flow of oil to the thrust bearing, the oil temperature at the inlet and outlet of the thrust bearing, water temperature at the outlet of the guide-bearing gate opening and governor hydraulic pressure. The temperature of the transformers in each bank is also taken hourly. (*Electrical World*, vol. 69, no. 16, April 21, 1917, pp. 740-744, 8 figs, *d*)

Measurements

THE EFFUSION METHOD OF DETERMINING GAS DENSITY, Junius David Edwards

The effusion method of determining gas density, which is based upon the fact that the times required for the escape of equal volumes of two gases under the same pressure through the same small orifice are approximately proportional to the square roots of the densities of the gases, was investigated in order to determine the accuracy of the method and its sources of error. In coöperation with a number of men employing this method in the natural-gas industry, a series of experiments was made using their apparatus under field conditions. It was found that results in error by more than 10 per cent were not unusual.

The theory of the effusion process was studied in order to determine the influence of the numerous variables affecting the apparent specific gravity. The effect of differences in physical properties upon the relative rates of effusion of air and hydrogen, argon, methane and carbon dioxide at different pressures was determined. A more detailed treatment of the theory in the light of these results will be given in another paper. The facts observed in this study together with the observations made on the effect of the effusion pressure, the confining medium, and the shape and size of the orifice have been used in determining the most favorable conditions of operation for this method.

It is very important that the orifice be of the proper size and shape. Recommendations have been made as to the most suitable type and form of apparatus for use and specifications given to guide in the construction of the orifice.

It has been shown that the apparent specific gravity, as determined by this method can be varied within rather wide limits by changing the conditions. However, by the observance of certain precautions in the construction and use of apparatus, it is possible to secure results accurate to about 2 per cent. The greatest precision is obtained where the physical properties of the gas tested show the least difference from those of air. Some further increase in accuracy and particularly in reliability can be gained by standardizing the apparatus as recommended. (*Bureau of Standards,* advance abstract of Technologic Paper No. 94)

The Relative Sensibility of the Average Eye to Light of Different Colors and Some Practical Applications to Radiation Problems, W. W. Coblentz and W. B. Emerson

In the present investigation the methods are practically the same as used by previous experimenters. In the visual measurements the spectral light was compared with a standard white light by means of a flicker photometer, and also an equality-of-brightness photometer. The source of white light was a standardized vacuum tungsten lamp. A cylindrical acetylene flame was used as a source of spectral light. The distribution of energy in the spectrum of the acetylene flame was determined with great care in view of the fact that the disagreement in previous work seemed to be due, in part, to uncertainties in radiometrically evaluating the light stimulus.

Visibility curves were obtained on 130 persons, of whom 7 were known to be color-blind. The visibility curve of the average eye, using 125 observers, is wider than previously observed.

As was to be expected, the visibility curves of no two persons appear to be exactly alike. When a visibility curve does not coincide with the average there is usually a marked departure from the average visibility in a given spectral region. This gives rise to (1) wide visibility curves with the maximum shifted toward the red, i.e., "red sensitive," (2) narrow curves with a sharp maximum in the green, and (3) curves with the maximum shifted toward the violet.

The data available indicate that 60 per cent of the cases examined fall into three quite evenly divided groups (i.e., 20 per cent roughly estimated in each group) which are either (1) red sensitive, (2) blue sensitive, or (3) average. Similarly, 30 per cent of the cases examined are quite evenly divided into three groups which fall below the average either (1) in the red, (2) in the blue, or (3) in both the red and the blue, thus giving rise to an apparently high sensibility in the green. One person in about 20 has a very wide visibility curve as compared with the average.

The point of maximum visibility is very different for different observers, and for the 125 persons the maximum is at -0.5576. The curve of average visibility, when corrected for selective transmission of the ocular media, including the yellow spot, is very symmetrical.

The complete paper gives a mathematical equation of the average visibility curve, and application of these data to physical photometry. Further applications are given in a separate paper.

Calculations are given showing that the eye responds to light having an intensity less than 1×10^{-10} watt.

This paper gives also data on diffused light and on the spectroscope used, and a screen is described which transmits radiations proportional to the average eye. (*Bureau of Standards,* advance abstract of Scientific Paper No. 303)

An Aneroid Calorimeter for Specific and Latent Heats, Nathan S. Osborne

The principle of the unstirred or "aneroid" type of calorimeter has been embodied in an instrument especially designed for determinations of the specific heat and latent heat of several substances in general use as refrigerating media.

Heat developed electrically in a coil located in the central axis of the cylindrical shell comprising the calorimeter is distributed by conduction to the calorimeter and contents whose initial and final temperatures when in thermal equilibrium are measured by a platinum-resistance thermometer.

Heat from other sources is excluded by enveloping the calorimeter with a metal jacket separated from it by the air space and keeping this jacket during measurements at the same temperature as the calorimeter surface, using multiple thermocouples to indicate this equality.

The calorimeter is adapted for use between -50 deg. and $+50$ deg. cent. and for pressures up to 70 atmospheres in experiments where the measured heat added is used either to change the temperature of the contents or to evaporate a portion of the contents withdrawn as superheated vapor; in the first case the specific heat and in the second the latent heat of vaporization being obtained when proper corrections are made. Such experiments are described in separate papers, this paper being devoted to the description of the instrument and its calibration.

Several features to which special attention has been given are:

1 Refinements to reduce errors in the evaluation of thermal leakage. These refinements include the following details:

a Location of the heater in the central axis of the calorimeter so that abrupt thermal irregularities produced by the heat developed therein may be subdued before affecting the surface

b Distribution of metal connections between calorimeter and jacket in such a way that the lead conduction is unaffected by inequalities in the surface temperature of the calorimeter

c Protection by means of superficial copper sheaths of calorimeter surface from abrupt variations in temperature such as may occur within during calorimetric measurements

d Method of indicating relative mean surface temperatures of calorimeter and jacket by means of multiple integrating thermocouples, which permits the evaluation of, and usually the annulment of, the thermal leakage.

2 Provision by means of a system of radial metal vanes for the distribution of heat throughout the contents.

3 Provision for insuring the dryness of vapor withdrawn by means of baffle-plate system.

4 Installation in the calorimeter of a strain-free type of platinum-resistance thermometer selected to give requisite accuracy.

5 Device for rapid cooling of the calorimeter consisting of a copper ring which can be moved within the jacket so as to thermally short-circuit the insulating air space and permit the escape of heat to the cooled jacket.

6 Thermo-regulated bath for keeping the temperature of the isothermal envelope or jacket always under control of the observer in order to avoid any unmeasured heat increments by thermal leakage.

Many other details are described which have a bearing on the convenience or accuracy in the use of the instrument.

The method of manipulation in making measurements of heat capacity is described, and the results given of an ex-

tended series of observations in the temperature range from —50 deg. to +50 deg. cent. to determine the heat capacity of the empty calorimeter. (*Bureau of Standards*, advance abstract of Scientific Paper No. 301)

Railroad Engineering

MALLET ARTICULATED LOCOMOTIVES FOR THE PHILADELPHIA & READING RAILWAY

Description of a heavy Mallet compound locomotive designed for pusher service over 3 per cent grades. These locomotives are of the 2-8-8-2 type and develop a tractive force of 98,400 lb. They are of special interest because of the restricted clearance limits imposed. The boiler center is placed 9 ft. 9 in. before the rail, and this apparently low elevation has increased the difficulty of working out some of the details of the design. The boiler is one of the largest Wooten boilers thus far built, with a diameter at the throat of 102 in. and a grate area of 108 sq. ft. It is designed for a pressure of 225 lb., but in service the safety valves are set at 210 lb. The equipment includes a Street stoker and power-operated firedoor and grate-shaker.

Owing to the restricted clearance limits it has been necessary to mount the safety valves in a specially designed casting which projects downward into a 26-in. circular opening in the boiler shell. This opening is placed just ahead of the combustion chamber. The rest of the equipment is not materially different from the usual practice on the Baldwin Mallet locomotives. (*Railway Review*, vol. 60, no. 18, May 5, 1917, pp. 620-622, 3 figs., *d*)

MCCLELLON WATER-TUBE FIREBOX

The McClellon water-tube firebox has been in the process of development for a number of years and a few years ago one was built and applied to a Boston & Maine locomotive.

Another design has been recently made on two units installed on locomotives on the N. Y., N. H. & H. R. R.

It has been the aim of the designer to eliminate the use of staybolts and to divide the firebox into individual units which may better resist the expansion and contraction forces in service and may be removed with but little difficulty. The only staybolts used in the firebox are in the throat and the foundation or mud ring, which is a chamber 7½ in. by 6 in., extending along the sides and back of the firebox. The sides and back head are made up of 6-in., 5⅜-in. and 5-in. water tubes and the crown is made up of three drums as shown in Fig. 8. The tubes connect the drums with the foundation ring. The boiler is also provided with a combustion chamber 44½ in. long, the sides of which are made up of tubes. These tubes follow the inside contour of the shell and extend from the outside drums to a circulating chamber which extends between the tube sheet and the throat. The chief method of construction of the firebox is by autogenous welding.

In the original article a photograph of the steam drums is reproduced. These drums were made from 1¼-in. plate planed down to ½ in. in thickness. The front end of these drums is shaped to fit the barrel of the boiler and to make suitable connection with the tube sheet. The two side drums are butt-welded for 12¼ in. back from this end to facilitate shaping, and for the remainder of their length have a single riveted butt seam with 5½ in. by 7-16 in. inside and outside welt straps.

The sides of the firebox are made up of fifteen 6-in. tubes equally spaced for over a distance of 91 in., which gives sufficient space between each tube to allow for expansion.

The combustion chamber is 44½ in. long and contains from the front to the back two 2½-in. tubes, eight 4-in. tubes and one 5-in. tube. These tubes extend between the side drums at the top and the circulating chamber at the bottom, being curved to the shape of the boiler shell. The circulating chamber consists of a ⅝-in. flanged plate. There is a direct connection between the boiler barrel and the circulating chamber and also between it and the throat.

These fireboxes were applied to two Mikado locomotives weighing a little over 250,000 lb. The firebox heating surface of the ordinary boiler was 239 sq. ft., and of the McClellon boiler 308 sq. ft. Also, there was a little larger amount of heating surface in the fire tubes in the McClellon boiler and the total square feet of heating surface, including the superheater flues, was 2827 sq. ft. for the ordinary boiler and 2937 sq. ft. for the McClellon boiler.

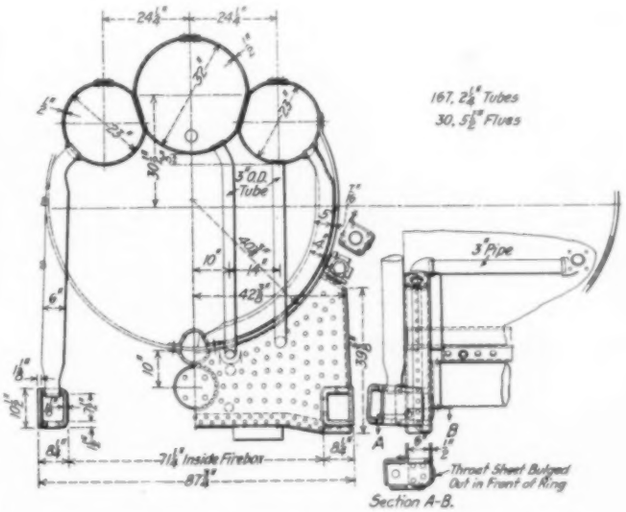


FIG. 8 SECTIONS SHOWING GENERAL DETAILS OF THE MCCLELLON FIREBOX

The locomotives with the McClellon boilers have not been in service long enough to determine the results. (*Railway Mechanical Engineer*, vol. 91, no. 5, May 1917, pp. 239-242, 6 figs., *d*.)

RESISTANCE OF PASSENGER CARS, D. C. Schmidt and H. H. Dunn

Data of an investigation of which the purpose was to establish the relation of resistance to speed for cars of various weights. The tests were made in regular through passenger service and it was found that the specific resistance is materially affected by the weight of the cars composing the train, and decreases as the average weight of the car increases.

The apparatus used with the dynamometer car produced continuous graphical records of the gross resistance of the train, the speed, time, brake-cylinder pressure, wind direction and wind velocity. All resistance values have been corrected for grade and for acceleration. The immediate purpose of the test was to define for each train the relation between net resistance and speed. All of these curves are brought together in Fig. 9.

This figure shows that at 20 m.p.h. the values of resistance fall between 4.1 and 6.3 lb. per ton, and at 70 m.p.h. between 8.0 and 11.4 lb. per ton. This variation is chiefly due to the difference in the average weights of cars composing the different trains. Trains composed of relatively light cars have higher resistance than trains composed of heavy cars.

The relation between resistance and average car weight have been graphically established in the following manner. If, in Fig. 9, at the point corresponding to 20 m.p.h., a perpendicular is erected, it will cut the curves in 18 points, each of which pertains to a particular train and defines for that train the average value of resistance at a speed of 20 m.p.h. If each of these resistance values are plotted with respect to

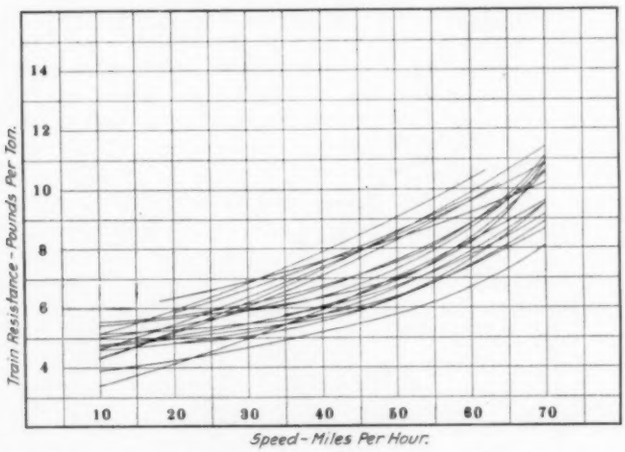


FIG. 9 RELATION BETWEEN RESISTANCE AND SPEED FOR THE 18 TRAINS TESTED

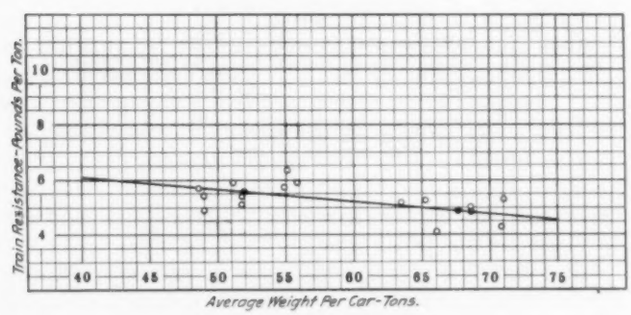


FIG. 10 RELATION BETWEEN RESISTANCE AND AVERAGE CAR WEIGHT FOR THE 18 TRAINS TESTED AT A SPEED OF 20 M.P.H.

the average car weight of the train to which it pertains, the diagram shown in Fig. 10 is obtained, which indicates that as the car weight increases the specific resistance decreases, the average weight of this decrease being shown by the straight line.

Six other straight lines have been determined defining this relation at 10, 30, 40, 50, 60 and 70 m.p.h.

As regards the numerical values appearing in the curves it should be borne in mind that they apply to trains running on level track at uniform speed in warm weather and under favorable conditions. Cold weather and high winds will both operate to increase the resistance above the amounts shown. (*American Railway Engineering Association*, Bulletin 194, abstracted through the *Railway Mechanical Engineer*, vol. 91, no. 5, May 1917, pp. 247-248, 5 figs., *e.*)

Steam Engineering

THE DETERIORATION OF CURTIS-RATEAU TURBINE BLADING, A. Fenwick

A paper devoted to the record and discussion of the behavior of certain materials used in turbine blading, based on a six years' experience in operating and maintaining the turbine plant of the Rand Power Company.

The turbines are of the combination Curtis-Rateau type. After passing through the first row of Curtis moving blades and a row of stationary blades fixed to a steel segment bolted to the turbine casing, the steam discharges into the casing in which the Curtis wheel revolves. The Curtis casing is a closed compartment separated from the Rateau portion by a cast-iron diaphragm. On the outer periphery of this diaphragm is a ring of guide blades forming nozzles which convert the steam pressure into velocity and give the steam the correct angle for impinging on the moving blades. The first ring of guide blades directs the steam from the Curtis casing on to the first Rateau wheel—termed in this paper the second-stage wheel.

Two main types of guide blading are in use, the first, termed a guide-blade ring, consists of inner and outer retaining rings cast round the blades. The guide ring is in two halves which butt together at the horizontal joint of the turbine casing.

The second type, the diaphragm, forms an integral part with the retaining rings, the complete diaphragm being cast in two halves. This type is called a guide-blade diaphragm.

The paper discusses the turbines by classes, starting with the 3000-kw. type. In this size in the Curtis stage and the first three low-pressure stages two materials have been tried, aluminum bronze and 5 per cent nickel steel. With the steel no particular trouble has been experienced from corrosion, and some sets have been running for six years.

The aluminum-bronze blades, on the other hand, proved quite unsuitable for this part of the turbine. The aluminum content disappears from the surface of the metal leaving a very brittle layer of copper. Where the section of metal is thin, as at the inlet and discharge edges of the blades, it breaks away like glass with light tapping. With continued use the outer layer cracks and flakes off, exposing the part underneath, which in turn flakes off until the blade is split up into several layers. Where a section of the blade is fairly heavy, as in the Curtis stage, the shape is gradually lost, but the body of the blade remains sound and seldom fails.

On the whole, the Curtis blades have a shorter life than the later stages, due apparently to the higher temperature in the Curtis casing. After leaving Stage 4 the deterioration takes a different form, erosion or pitting at the back or convex portion of the blade being usual. In fact, the pitting in Stages 5, 6, 7 and 8 looks as though chemical action had taken place, and may be due to certain impurities in the steam becoming active in the presence of moisture.

The same unsatisfactory experience with aluminum bronze in the Curtis blading was found in the 9600-kw. class. On the other hand, the brass blades in Stages 6 to 9 have been found to be in excellent condition from a deterioration point of view, but in several cases have been severely damaged mechanically from various causes and successfully straightened out.

The aluminum-bronze blades in Stages 10, 11 and 12 have proved satisfactory, but in Stage 13 breakages of the blades have occurred. The blades are secured to the wheel by a tee, headed root and fracture frequently occurs across the neck of the tee. The stress at the point is not excessive, approximately 3 tons per sq. in. A new blade was tested at the Government Laboratory and showed an ability to stand 44.9 tons, but an

old blade before fracture had a strength of only 29.8 tons per sq. in. Although there is very little difference in outward appearance, it would seem, therefore, that the material has lost a good deal of its original strength. In some cases the blades have fractured about 1¼ in. above the rim of the wheel, i. e., just above the distance piece.

The experience with the 4000-kw. compressor-turbine class was essentially similar to that with the main turbines.

As a general conclusion the author expresses his belief that aluminum bronze is totally unsuitable for use as a blade material in the high-temperature stages, but excellent results have been obtained with it in the low-temperature stages. Five per cent nickel steel has so far given good service where used. Brass stands the temperature well and in some cases has replaced aluminum bronze with satisfactory results.

A similar set of observations is reported on stationary blading. In this connection the writer comes to the conclusion that while cast iron is far from being the best material for inlet nozzles, it is very much cheaper than anything else and for this reason should receive consideration. Steel blades were tried and after running 3000 hours on a 9600-kw. turbine were found to be in excellent condition.

An interesting observation was made in this connection. A nozzle was quite damaged and a test was run with it on the efficiency of the turbine. It was found that actually the turbine was as efficient as if nozzles in good condition had been used. Hence it was obviously sound practice to remove that part which invariably broke away and the nozzle shown in Fig. 11 has therefore been made with a V-shaped portion cut out. Since this nozzle has been used on the main turbines they have been practically free from breakage of nozzle vanes.

FIG. 11 IMPROVED INLET NOZZLE FOR STEAM TURBINES WITH A PORTION OF THE VANE CUT OUT

Aluminum bronze was originally used on several turbines but proved totally unsuitable, as the metal rapidly disintegrates, owing to temperature. Twenty-five per cent nickel steel stood up well for a time, but became brittle with use. Five per cent nickel steel stands up very well and is now used exclusively for all *main* turbine stationary segment blading.

A similar discussion covers the subject of guide blading. The article also discusses in detail in an interesting manner the question of stresses imposed on the blades. This part cannot be abstracted, because of lack of space. (*The Journal of the South African Institution of Engineers*, vol. 15, no. 8, March 1917, pp. 143-178, 25 figs., *eA*)

BURNING BLAST-FURNACE GAS UNDER BOILERS

Herman C. Siebert, Experimental Engineer of the Duquesne Works, Carnegie Steel Company, presented the following data of experiments with various burners in connection with different boilers giving their air-aspirating characteristics.

The common type of Kennedy blast-furnace-gas burner with its aspirating characteristic is shown in Fig. 12. There is in the furnace an auxiliary bridge wall and a cooled grate between it and the main bridge wall, also a metal screen which permits varying the air opening between boiler and burner. The amount of air is varied by moving the screen in and out over the burner. The characteristic of this type of burner shows that the proper amount of air is established at a pressure of 2 in. when the screen is open. When the screen is closed, the correct amount of air is drawn in at 1 in. gas pressure. At all other gas pressures the air supply is positive or negative in amount of excess. Fig. 13 gives characteristics for two other types of aspirating burners, both similar to that of Fig. 12, except that the proper amount of air is aspirated at a different gas pressure. Fig. 14 shows the characteristic for a special burner and indicates what can be accomplished

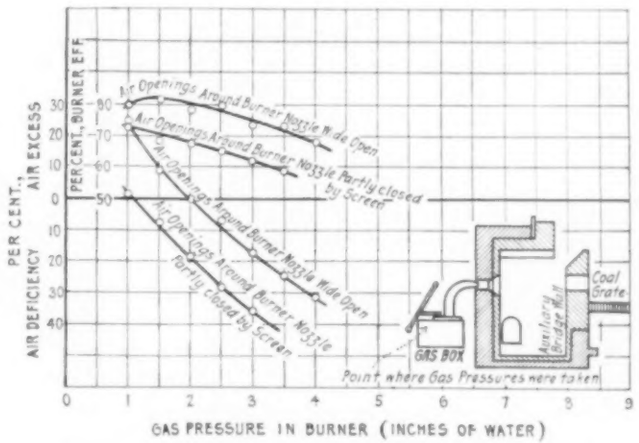

PER CENT., BURNER EFF.
PER CENT., AIR EXCESS
AIR DEFICIENCY
Air Openings Around Burner Nozzle Wide Open
Air Openings Around Burner Nozzle Partly closed by Screen
Air Openings Around Burner Nozzle Wide Open
Air Openings Around Burner Nozzle Partly Closed by Screen
GAS BOX
Auxiliary Bridge Wall
Coal Grate
Point where Gas Pressures were taken
GAS PRESSURE IN BURNER (INCHES OF WATER)

FIG. 12 AIR-ASPIRATING CHARACTERISTICS AND BURNER EFFICIENCIES OF KENNEDY BLAST-FURNACE-GAS BURNERS

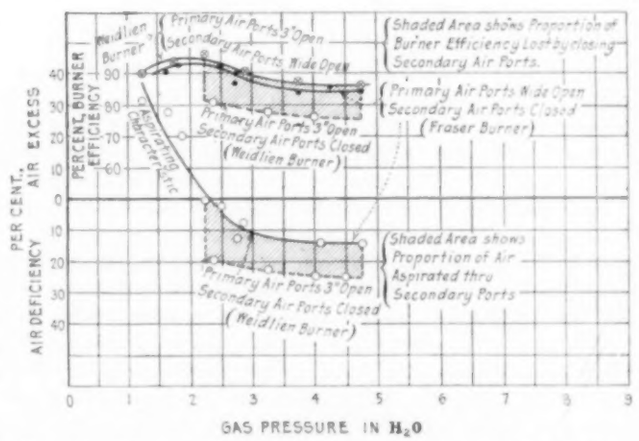

Weidlien Burner
Primary Air Ports 3" Open
Secondary Air Ports Wide Open
Shaded Area shows Proportion of Burner Efficiency Lost by closing Secondary Air Ports.
Primary Air Ports Wide Open
Secondary Air Ports Closed
(Fraser Burner)
Primary Air Ports 3" Open
Secondary Air Ports Closed
(Weidlien Burner)
Aspirating Characteristic
Shaded Area shows Proportion of Air Aspirated thru Secondary Ports
PER CENT., BURNER EFFICIENCY
PER CENT., AIR EXCESS
AIR DEFICIENCY
GAS PRESSURE IN H_2O

FIG. 13 BURNER EFFICIENCIES AND ASPIRATING CHARACTERISTICS OF KLING-WEIDLEIN-FRASER AND BRADSHAW BLAST-FURNACE-GAS BURNERS

in the way of air supply if the port area is large enough and is varied to suit the different gas pressures. In this case the air supply was controlled by gas analysis taken from the combustion chamber and the port area.

Some experiments were also made with a mixing burner in which an explosive mixture was burned, leaving the nozzle at a velocity greater than the ignition velocity (very low for blast furnace gas). With this type of burner up to 270 per cent of boiler rating was developed.

S. G. Brigel, of the Huessener Engineering Company, Pittsburgh, stated that when running Stirling boilers on loads varying from 130 to 160 per cent, he found stack temperatures

for complete combustion with low excessive air of between 600 and 650 deg. fahr.; and in the case of Rust boilers, he found similar loads coinciding with similar temperatures. On the other hand whenever he has run Babcock & Wilcox boilers, he found that stack temperatures did not rise nearly as quickly with an increase in load. A large number of figures taken during operation on over 100 Babcock & Wilcox boilers fired by gas exclusively, show stack temperatures ranging from 530 deg. fahr. to 600 deg. fahr. for an average load of 165 per cent.

As regards the difference in boilers which do or do not take advantage of primary mixing of gas and air, the speaker stated that any burner can be regulated in such a manner that it gives complete combustion with a very low excess of air. But such regulation may require constant attention and in ordinary practice be beyond the capacity of the usual boiler-house crew.

In this respect a test which was made at one of the Eastern

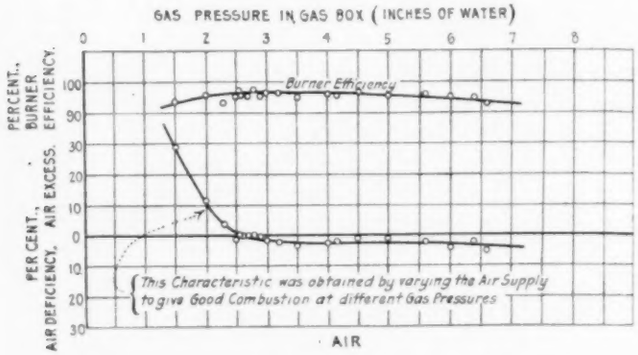


FIG. 14 AIR-ASPIRATING CHARACTERISTICS AND BURNER EFFICIENCY OF SPECIAL BLAST-FURNACE-GAS PRODUCER HAVING LARGE PORT AREAS AND WIDE ADJUSTMENT TO SUIT DIFFERENT GAS PRESSURES

steel works may be of interest. Two boilers, one equipped with a burner working with secondary air only, the other with a burner working with primary air only, were tested side by side after they had been adjusted in such a manner that both boilers showed 22 per cent CO_2, 1.0 per cent oxygen, and no CO in the combustion chamber. The three successive tests taken on both boilers under identical conditions showed that the boiler utilizing primary air only changed the combustion of the gas in the combustion chamber due to change of gas pressure, to a lower CO_2 of 19 per cent, without any unburnt CO; whilst the boiler working with secondary air went down as low as 17 per cent CO_2 with 6 per cent unburnt CO. This appears to be an excellent illustration of the effect of varying boiler draft on the condition of the combustion chamber. (*Proceedings of the Engineers' Society of Western Pennsylvania*, vol. 33, no. 3, April 1917, pages 167-198, 7 figs., *ep.*)

Varia

HYDRAULIC TEST OF PIPE CONNECTIONS

Data of tests conducted under the supervision of F. H. Sibley, Mem.Am.Soc.M.E., in the Machine Construction Laboratory of the University of Kansas. They refer to determination of the relative strength of welded and screwed connections in steel pipe of various sizes when subjected to internal hydraulic pressure. The article briefly describes and illustrates the apparatus used.

The pipe samples ranging from 2 to 4 in. in diameter were cut from standard black steel pipe, the welded specimens being made by operators of a commercial acetylene welding company, while the screw connections were made with malleable-iron couplings and fittings by expert pipe fitters.

The 2- and 3-in. welded specimens failed by splitting along the longitudinal seams of the pipe, the break stopping at the welded section. The 4-in. welded specimens did not fail either in the weld or in the pipe seam (the pressure applied was 5100 lb. per sq. in.). The bursting pressures for the screw connections were considerably below those of the welded specimens and all failed in the fitting. Great difficulty was experienced in testing the screwed connections, because sand holes developed and water leaked through the castings to such an extent that it was almost impossible to reach the point of rupture.

The results of these tests appear to indicate that the strength of a welded-pipe connection is practically the same as that of an unwelded pipe and can be stronger than the rest of the pipe by building up the weld. It appears also that the strength of the welded pipe connection is greater than that of the malleable-iron screwed fitting. (*Iron Age*, vol. 99, no. 18, May 3, 1917, pp. 1070-1071, 1 fig., *e.*)

AIR DRYING FOR BLAST FURNACES, Leon Cammen

Brief characteristics of the main processes of air drying for blast furnaces, both cryogenic and chemical, and description of a process based on the fact that the drying action of a solution of calcium chloride depends on two things: the degree of concentration and the temperature at which the liquor is maintained.

The process involves the use of the following cycle of operations. In the first place, air is passed through a highly concentrated solution of calcium chloride maintained at a proper low temperature and is there freed of such moisture as it may contain. The cold brine which moves in countercurrent to the air after meeting it, proceeds to an evaporator where it is brought back to the initial degree of concentration. It is then sent along a series of cooling coils until it reaches the desired low temperature and is ready to meet the incoming air again. The essential feature of the process is the fact that in the evaporator only a concentration of the brine, and not drying of the salt (which latter is a process requiring a very large specific expenditure of heat), is carried on. This results in the use of comparatively low temperatures and economy of heat consumption.

The brine leaves the refrigerator at a temperature of 16 deg. fahr. and a concentration of 40 per cent. By the time it passes from contact with the incoming air, it has a temperature of, say 25 deg. fahr. and a concentration of 30 per cent. Attention is called in this connection to the fact that the incoming warm and moist air is first met by the comparatively warm brine. While brine of 25 deg. fahr. and 30 per cent concentration is still capable of taking out a large amount of moisture from air at say 80 deg. and a content of 7 grains of water per cu. ft. (the precompression system is apparently used here), the comparatively dry and by then fairly cool air in its last stage of flow passes through a layer of 40 per cent brine at 16 deg. fahr. which is intensely hygroscopic. In this way the most efficient system is adopted both as to the distribution of temperatures and distribution of concentrations. (*Proceedings of the Engineers' Society of Western Pennsylvania*, vol. 33, no. 3, April 1917, pp. 199-204, 1 fig., *d.*)

MECHANICAL-EFFICIENCY TESTS FOR MACHINE TOOLS, G. W. Burley

In dealing with mechanical-efficiency tests for machine tools the writer, in his book recently published, divides the subject into two parts: input determinations and output determinations.

The determination of the amount of input energy may be made in at least three different ways, the electric-motor method, the transmission-dynamometer method, and the cradle-dynamometer method.

The paper discusses in detail the various types of dynamometers and the dynamometer curves referring thereto, such as the transmission dynamometer and the torsion dynamometer.

Among other things, as a method of determining the output of a motor is mentioned the use of a hydraulic piston and cylinder filled with oil or kerosene, and an ordinary pressure or engine indicator. This method does not yield the true output of the motor, however, and does not cover the mechanical losses in the bearings.

An article on the determination of the output of machine tools is promised in a future issue. (*Railway Gazette*, vol. 26, no. 13, March 30, 1917, pp. 386-388, 5 figs., *d*)

REPORT ON HEAT-INSULATING MATERIALS

Results of tests by Sargent and Lundy, Consulting Engineers, of Chicago, of various heat-insulating materials compared with tests of common firebrick.

The first object of this test was to determine the relative thermal insulating value of materials examined.

The materials were used in dimensions of standard bricks, so as to have the samples equal in this respect. The idea worked on for comparison was to subject the brick to a high temperature at the end *A*, Fig. 1. Then if the top, bottom and sides were thoroughly insulated the heat would be radiated

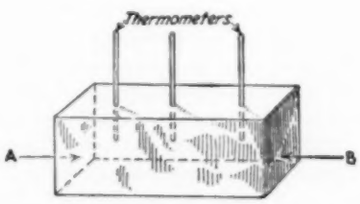


FIG. 15 DIAGRAM SHOWING LOCATION OF THERMOMETERS IN EXPERIMENTAL BRICK

from the exposed end *B*, and thermometers placed at various distances between *A* and *B* would show a uniform drop in temperature. With the same temperature at *A*, a brick made of a good insulating material would give lower readings on the thermometers placed in the brick than would be the case for a poor insulating material and the temperature gradient would have a different shape.

This process involves the difficulty of thoroughly insulating the top, bottom and sides of the bricks, but in the course of the test it was found that if the top, bottom and side insulation was made practically the same for each material, the comparison would be reliable. The method of testing was to read all thermometers, then place the gasoline torch in position and take readings every 15 or 30 min., the idea being to keep the high temperature source of heat as steady as possible. The gasoline torch did not possess much flexibility and was difficult to regulate satisfactorily.

Another method of test involved the use of an electric heater.

On the whole, it was found that materials have not as good an insulating value at high temperatures as at low ones. To express this variation in insulating value with the temperature, a relation similar to Ohm's law has been derived. The unit taken has been called "the thermal ohm," and is expressed by dividing the temperature difference by the B.t.u. radiated per hour. The values for some of the materials have been calculated and are given in Fig. 16. They show practically straight

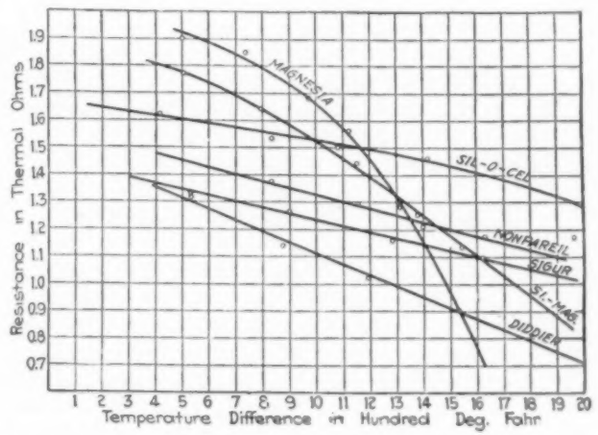


FIG. 16 CURVES SHOWING HEAT-RESISTING PROPERTIES OF VARIOUS INSULATING MATERIALS

lines, except for two materials, of which one, Si-Mag (combination of sigur and magnesia), shows the thermal resistance, which decreases directly as the temperature difference.

Magnesia falls off so rapidly at the high temperature because it becomes disintegrated through a chemical change.

An effort was also made to find the equivalent thickness of material required to give equal insulation, for which purpose it was necessary to demonstrate experimentally the laws of thermal resistance.

Further tests were made to secure some data on the physical properties of insulating materials: in particular, the weight of water absorbed; and it was found that in some cases insulating materials absorbed considerably more than their own weight of water. (*Power*, vol. 44, no. 18, May 1, 1917, pp. 593-596, 14 figs., *e*.)

TRANSLATION OF FORMULÆ, P. M. Heldt

Discussion of the transformation of equations from one system of units to another, with additional reference to rational equations, which are universally true so long as the rational system of units is used.

If a formula is based on the metric system and the design to which it is applied is in inch units, the question of transformation becomes an important one. Of course, in isolated cases it is possible to convert the inch measurements in the design into metric units, apply the equation and reconvert the result, which would be in metric units, into inch units. Apart from being rather tedious, the process is, however, not conveniently applicable where a number of operations of this nature have to be carried out, and in such cases it becomes necessary to find a simpler way of applying equations derived in units of one system to problems in which the data are expressed in another system.

A certain class of formula is universally true so long as a rational system of units is used. Such equations are called rational, and the test of a rational equation consists in substituting for each factor representing a physical quantity, the dimensions in terms of the fundamental quantities (length, mass, time), and seeing whether, when thus transformed, the equation holds true.

In many equations, however, two different units are used for the same quantity. For example, in the equation where the speed of a car is expressed in terms of wheel diameter, engine-speed revolution and gear reduction, two different units of length are generally used—the inch for the wheel diameter and the mile for the distance covered per hour—and two units of time—the minute for the engine speed, and the hour for the car speed. This equation may, however, be transformed into a rational equation by using only one unit of length, say, the inch, and one unit of time, the minute. In this case the equation becomes

$$s = \frac{d\pi n}{r}$$

where s = speed of car, d = wheel diameter, n = engine revolutions per unit of time and r = gear reduction. This equation would give the car speed in inches per minute, but if the engine speed is given in revolutions per minute, the wheel diameter in inches, and the result is required in miles per hour, the equation becomes

$$s = \frac{nd}{336r} \text{ m.p.h.}$$

Now, if metric units were used, the wheel diameter given in millimeters and the result required in kilometers per hour, s would be 1.608 times as great (1 mile = 1.608 kilometers) and d 25.4 times as great (1 in. = 25.4 mm.). Therefore, denoting the numerical coefficients by $1/x$,

$$1.608s = \frac{nd \times 25.4}{xr}$$

which would give for x the following equation:

$$x = \frac{336 \times 25.4}{1.608} = 5310$$

and hence the metric formula would read

$$s^1 = \frac{nd^1}{5310r} \text{ km.p.h.}$$

Of course, it is not necessary to go through all these intermediary steps the next time, and a simple conversion factor $x = 5310$ can be used.

As examples of the application of the methods of transformation of equations from one system of units to another, the writer gives the formula for determining the tax horsepower of automobile motors in Germany, and the formula for the absolute pressure of saturated steam as a function of the absolute temperature in deg. fahr. That part of the article dealing with the latter is here reproduced.

The equation for this relation is:

$$\log p = 10.515354 - (4873.71/t) - 0.00405096t + 0.00000139296t^2$$

Now, suppose that it is desired to transform this equation so the temperature may be inserted in deg. cent. (absolute) and the pressure will be obtained in kg. per sq. cm. We then have:

$$\log(p/14.22) = a - b/0.555t - 0.555\,ct + 0.309dt^2$$
$$\log p - \log 14.22 = a - b/0.555t - 0.555ct + 0.309dt^2$$
$$\log p = \log 14.22 + a - b/0.555t - 0.555ct + 0.309dt^2$$
$$\log p = 1.1529 + a - b/0.555t - 0.555ct + 0.309dt^2$$

and $10.515354 - (4873.71/t - 0.00405096t + 0.00000139296t^2 = 1.1529 + a - b/0.555t - 0.555ct + 0.309dt^2$

This equation can be satisfied only if the factors in both terms containing the same power of t are equal, that is:

$10.515354 = 1.1529 + a$	$a = 9.3624$
$b/0.555t = 4873.71t$	$b = 2705$
$0.555ct = 0.00405096t$	$c = 0.00729$
$0.309dt^2 = 0.00000139296t^2$	$d = 0.000004515$

Hence the absolute pressure p'' of saturated steam in kg. per sq. cm. is given by the following equation, in which t'' is the absolute temperature in deg. cent: $\log p'' = 9.3624 - 2705/t'' - 0.00729t'' + 0.000004515t^2$. (*Horseless Age*, Engineering Edition, vol. 40, no. 2, April 15, 1917, pp. 1-2 (Engineering Section), *pm*)

Technical Paper 137 of the U. S. Bureau of Mines, of which an abstract will be found in the present issue of THE JOURNAL, is likely to become classical as an investigation of a difficult subject unusually free from unessential details. Among the conclusions established by this investigation, the two probably most important are that the weight of air forced through the fuel bed per pound of fuel burned or gasified is constant; and next, that above a certain distance from the fuel bed there is a large percentage of combustible in the gas and no oxygen to burn it. The investigation is rich in practical suggestions, and must be considered as a valuable contribution to our knowledge of the processes going on in a hand-fired furnace. As regards the numerical values obtained, however, it must be borne in mind before they are used in the design of commercial equipment that they were obtained from an experimental installation using picked fuel.

According to the *Iron Age* for May 3, 1917, J. W. Flavelle, Chairman of the Imperial Munitions Board in Canada, has furnished the Finance Minister with a striking statement showing the extent of the business in munitions built up in Canada with the financial assistance furnished by the Dominion Government. The total value of orders received by the Imperial Munitions Board of Ottawa is $850,000,000, which is equal to the entire international trade of Canada, imports and exports, of 1912. The value of the munitions shipped to March 30 was $470,000,000, the total disbursements to April 30 being $543,000,000. There are 630 factories, chemical and loading plants in operation carrying out the orders of the board. The cash disbursements for March were $41,000,000 and for April will be $43,000,000. Toward the financing of this immense business the Dominion Government has contributed $200,000,000 as a loan to the Imperial Treasury, and arranged with the Canadian banks for advances aggregating $100,000,000.

Official announcement has been made from Ottawa concerning the proposed extensive shipbuilding program, which was foreshadowed some six weeks ago. Orders have been placed for steel ships in Canada up to the full limit of the steel plates available during the next 15 months, and a good many wooden vessels will be built in the Dominion as well. The Dominion Government's part consists in advancing a loan of $10,000,000 to the Imperial Munitions Board, Ottawa. This Board has recently placed large orders for steel plates and will probably be placing additional orders in the near future.

HOURS, FATIGUE AND HEALTH IN BRITISH MUNITION FACTORIES

The following outline of the main conclusions arrived at by the British Health of Munition Workers Committee is taken from reprints of the memoranda of this committee made by the Bureau of Labor Statistics of the United States Department of Labor (Bulletin, Whole No. 221, or Industrial Accidents and Hygiene Series, No. 15, April 1917).

This committee was appointed in September 1915 by the Minister of Munitions, and on the basis of evidence taken in various industrial centers has compiled and published some fifteen memoranda dealing with various aspects of the subject. As these memoranda are the work of men especially qualified by technical knowledge and wide experience, they are of particular value in this country at the present time.

As regards Sunday labor, the committee states that the evidence adduced has led it strongly to hold that if the maximum output is to be secured and maintained for any length of time a weekly period of rest must be allowed. Except for quite short periods continuous work in its view is a profound mistake and does not pay—output is not increased.

The committee also makes the significant statement that, in their opinion the higher management even more certainly require definite periods of rest. These individuals have never spared themselves; they carry a heavy burden of responsibility and, moreover, cannot be replaced. The committee has with regret noted among them obvious signs of overwork, and it is of primary importance in the interest of the nation that they should be allowed that rest which is essential to the maintenance of their health.

As regards hours of work the committee calls attention to the fact that overtime fell mainly to the lot of the most highly skilled workers (tool and gage makers, tool setters, etc.) as they are the most difficult to obtain. At one time cases of men working as much as 90 hours per week were met, and while more recently there has been a tendency to reduce the hours, weekly totals of 70 to 80 hours are still frequent. The committee is satisfied that hours such as these cannot be worked with impunity, and most strongly urges that every effort should be made to extend the shift system to this branch of industry as rapidly as possible.

The committee has not found that as yet the strain of long hours has caused any serious breakdown among workers, but there is medical evidence to the effect that long hours are beginning to make themselves felt upon the older men and upon those who suffer from physical infirmity. There is reason for believing, however, that the better food that workers have been able to enjoy in consequence of increased pay has helped to counteract the strain of long hours.

Among the executives and foreman there is evidence of considerable fatigue, and numerous instances have been brought to the notice of the committee where men of this class have had to be allowed special holidays to enable them to recuperate. The committee, therefore, while recognizing that overtime must continue, suggests certain definite restrictions to which it should be submitted, especially in the case of women and girls.

As regards the work of women engaged in moderately heavy work the committee has come to the conclusion that in order to attain a maximum output such women should not work more than 60 hours a week. In fact, an equally good total output would be maintained if the actual working hours were reduced to 56 or less per week. For example, one group of operatives, 17 in number, worked only 51.8 to 62.6 hours per week for five weeks in June and July and during the last three weeks of this period their hourly output was 18 per cent greater than that of another group of 14 operatives who were working the usual long hours.

As regards men engaged in heavy labor, data are not very complete, but as regards boys of 14 to 17, a reduction in the hours of labor from 73.3 to 57 produced an increase of output to the astonishing extent of one-third to one-half, which indicates that the boys must have been overworked by long hours and that a reduction of 8 to 12 hours materially accelerated their rate of production.

On the whole, the committee comes to the conclusion that the hours of labor should be varied between wide limits according to the character of the work performed, and not maintained uniform for all types of labor and for workers of both sexes; and that where long hours of labor on the part of munition workers are necessary, an effort should be made to have them shut up in the factories for as short a time as possible.

In this connection attention is called to the importance of greater promptness in starting work. There can be no necessity for the waste of 25 min. in starting and stopping work, as was the case in a shop under investigation.

The custom in many munitions works is to work for a spell of 5 hours and then after an hour's interval for another spell of 4½ to 5 hours, which leads to spells which are undoubtedly too long in many types of munition work. A better plan would be to arrange for regular rest pauses in between. For instance, a 10-min. break in the middle of the morning and afternoon spells during which the operatives remain at their machines to take tea or other nutriment.

Other memoranda discuss the subjects of industrial fatigue and the special diseases connected with the manufacture of munitions, in particular various forms of poisoning due to the handling of explosives.

A new type of gas engine recently announced is essentially an internal-combustion engine in which air is compressed and mixed with oil which is atomized and ignited by an electric spark. The resulting intensely hot flame of combustion is brought into contact with small quantities of water which cools the gases to a practical working temperature while generating a desirable amount of steam, which, combined with the gases of combustion, enters the power cylinders.

The following claims are made for the engine: Starting without any previous heating, directly with the oil, by hand or electric cranking or by compressed air. Only one spark plug is used, regardless of the number of cylinders. When the engine is under way, the current is turned off. Ignition outfits are not required, as a battery with coil and spark plug will suffice. No heat is lost through water jackets, and little power is wasted in the low-pressure exhaust. The water used is easily condensed and returned to the tank. There are no objectionable carbon deposits. No data of tests of the engine are yet available.

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

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LIBRARY NOTES

From the Libraries of the Four Founder Societies and the United Engineering Society, in the Engineering Societies Building, New York City

EVERY library has two problems: to collect the material of interest to its patrons and to make it accessible to them with the greatest possible ease.

The history of the Library of the Engineering Societies illustrates an endeavor to meet these two problems. Started as four independent libraries, nothing was more logical than the consolidation of the four into one, with a consequent avoidance of the waste due to duplication. Instead of libraries of civil, mining, mechanical and electrical engineering, we have a library of engineering, equipped to meet the requirements of an inquirer, regardless of the specific subject in which he may be interested.

The Library covers these four main branches of engineering very effectively. It is especially well supplied with periodicals, the most important depository of modern professional literature. The standard reference books and the more important texts are also included. As it becomes possible, the literature of other technologic subjects is being added, in the hope that there may sometime result the ideal collection, able to supply the records of all important previous work on any professional problem which an engineer may meet. To accomplish the ideal will require time and money, but the acknowledged value of the result will more than compensate for the expense. Engineers who wish to assist in the advancement of engineering should consider the benefits which will accrue from additions to the endowment fund of the Library.

Side by side with the extension of the collection, the problem of making it accessible must be faced. Most engineers are too busy to spare the time needed to search through long files of periodicals, or to make copies of desired articles, so it is necessary to provide assistance. To meet this need, the Library Service Bureau has been established as an adjunct to the Library. The Bureau will make lists of references to the articles on any topic, and will, if desired, make copies of them or translate them from other languages. It will send notices of new articles on any topic as they appear in the current periodicals. In fact, its possible forms of service are too various for listing, all that can be said is that it stands ready to undertake any work dealing with professional literature. For this type of work it has been necessary to arrange a schedule of fees, covering the cost of this work to the Library. Information on this subject will be given gladly. The Service Bureau has been of assistance to engineers all over the world, saving time for those to whom libraries are accessible and providing a practical method of reference for those in localities where books are not available.

The future work of the Library is to develop the greatest possible efficiency in these two directions, in the hope that it may ultimately become the largest engineering library in the world, and that it may be able, through a corps of highly trained expert bibliographers, to provide definite references to any material in point. Such an institution will be one of the most valuable aids in the promotion of the profession. It will have an international usefulness, as it will not duplicate the work of any existing institution.

HARRISON W. CRAVER.
Librarian.

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PERSONALS

IN these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by June 16 in order to appear in the July issue.

CHANGES OF POSITION

HORACE H. NEWSOM, formerly factory manager of the Perfection Spring Company, Cleveland, O., has become affiliated with the Standard Parts Company of the same city.

L. C. WELCH, formerly connected with The Imperial Oil Company, Ltd., Sarnia, Canada, has become identified with The Midwest Refining Company, Casper, Wyoming.

JOHN D. RIGGS, formerly associated with the Indestructible Wheel Company, Lebanon, Ind., has entered the employ of the Link-Belt Company, Indianapolis, Ind.

GEORGE B. PRESTON, formerly assistant professor of steam engineering, Columbia University, New York, has become associated with The J. G. White Engineering Corporation, New York.

I. ALBERT BAUM has severed his connection as city engineer of Texarkana, Ark., and has accepted the position of assistant manager of the LaSalle Engineering Company, Chicago, Ill.

GEORGE F. READ has severed his connection with E. I. duPont de Nemours and Company, Penns Grove, N. J., and has accepted a position with The Celluloid Company of Newark, N. J.

ALBERT BUENGER, formerly heating and ventilating engineer with Smith Hinchman and Grylls, Detroit, Mich., has become identified with the Charles L. Pillsbury Company, St. Paul, Minn.

ULDRIC THOMPSON, JR., formerly chief engineer of the T. A. Gillespie Company's plant at Parlin, N. J., has become associated with Westinghouse, Church, Kerr and Company of New York.

EUGENE L. BROWN, JR., formerly chief deputy inspector of boilers and elevators of the City of St. Louis, Mo., has accepted the position of engineer with the Illinois Stoker Company of Alton, Ill.

BARRETT W. MORRISON has left the employ of the Westinghouse Machine Company, East Pittsburgh, Pa., and has accepted a position with the Great Western Sugar Company, Billings, Mont.

RUSSELL J. HAWN, formerly with the Ohio Chemical Company, Springfield, Ohio, in the capacity of manager, has become associated with the Oakland Chemical Company, Rossville, S. I., N. Y.

EMILE H. NATE has become consulting engineer with Hammerston and Nate, New York. He was, until recently, associated with the Nate-Earle Company, Inc., New York, as president and treasurer.

W. R. CRUTE has assumed the duties of chief engineer of the Champion Fiber Company, Canton, N. C. He was formerly engineer with the Norfolk and Western Railway Company, Pocahontas, Va.

ARTHUR L. JENNINGS, formerly connected with the McGill Metal Company, Valparaiso, Ind., as general manager, has accepted the position of treasurer of the John T. Robinson Company, Boston, Mass.

JOHN J. EASON, formerly assistant superintendent of the mechanical division of the Panama Canal, Balboa, Canal Zone, has been appointed assistant shop superintendent at the Navy Yard, Norfolk, Va.

WELLES H. SELLEW, formerly mechanical engineer with the Canadian Car and Foundry Company, Kingsland, N. J., has accepted a similar position with the American Chicle Company, Long Island City, N. Y.

HARRY A. WARD, formerly in the employ of the Sterling Blower Company, New York, as sales engineer, has taken up the duties of engineer of plants with the American Oak Leather Company, Cincinnati, O.

JACOB L. MUELLER, until recently metallurgist with the Springfield Facing Company, Springfield, Mass., has accepted the position of mechanical engineer with the American Chain Company, Inc., Bridgeport, Conn.

GEORGE S. BARKER, formerly designing draftsman of the Niles-Bement-Pond Company, New York, has accepted the position of mechanical engineer with the Lucey Manufacturing Corporation, Chattanooga, Tenn.

HARRY O. HAGSTROM has become affiliated with the Elevator Supplies Company, Inc., Philadelphia, Pa. He was until recently connected with the Elevator Supply and Repair Company, New York, as sales engineer.

GRAHAM H. ANTHONY has severed his connection with the William L. Gilbert Clock Company, Winsted, Conn., as equipment superintendent, to take a position with The Allen Manufacturing Company, of Hartford, Conn.

BENJAMIN C. SHAW has accepted a position with the Boston Duck Company, Bondsville, Mass. He was formerly associated with the Warren Cotton Mills, West Warren, Mass., in the capacity of master mechanic.

ERNEST H. HAWKINS, formerly connected with the Allis-Chalmers Manufacturing Company, Philadelphia, Pa., has become associated with the purchasing department of E. I. duPont de Nemours and Company, Wilmington, Del.

ARTHUR D. STANCLIFF, until recently associated with the Hawkeye Portland Cement Company, Des Moines, Ia., has assumed the duties of superintendent of the Western States Portland Cement Company, Independence, Kan.

LOUIS H. MESKER has become affiliated with The Cleveland Milling Machine Company, Cleveland, O. He was until recently connected with Kearney and Trecker Company, Milwaukee, Wis., in the capacity of sales manager.

JAMES H. OAK has resigned his position as general foreman of the New England Westinghouse Company, Chicopee Falls, Mass., and has assumed the duties of superintendent of the National Automatic Machine Company, Brattleboro, Vt.

JOHN J. CHISHOLM has resigned his position as superintendent of power for the Tennessee Coal, Iron and Railroad Company at Ensley, Ala., and has taken up similar duties with the New Orleans Railway and Light Company, New Orleans, La.

CLAYTON A. SWIGGETT, formerly associated with the Western States Portland Cement Company, Independence, Kan., as superintendent, has entered the employ of the Lehigh Portland Cement Company, Iola, Kan., in a similar capacity.

EDGAR T. SPIDY, until recently connected with the Canadian Pacific Railway Shops, Winnipeg, Canada, in the capacity of shop engineer, has assumed the duties of production engineer with the Canadian Ingersoll-Rand Company, Sherbrooke, Que., Canada.

ROBERT H. WALLACE, until recently connected with the Remington Arms and Ammunition Company, Bridgeport, Conn., in the capacity of experimental engineer, has assumed the duties of shop superintendent of the Bailey Meter Company, Boston, Mass.

LEE E. WALKER has accepted a position with the Haynes Stellite Company of Kokomo, Ind., with headquarters in Philadelphia, Pa. He was until recently connected with the Baldwin Locomotive Works, Eddystone, Pa., as foreman of the French Shell Shop.

FRANK H. SCHUBART, formerly district manager for the Wheeler Condenser and Engineering Company, St. Louis, Mo., has become associated with the Union Electric Light and Power Company of the same city, as assistant chief engineer of power plants.

EDGAR G. SCOTT, until recently connected with Ludlow Manufacturing Associates, Ludlow, Mass., in the capacity of superintendent of power and repair shops, has become identified with the Joseph Campbell Company, Camden, N. J., as mechanical engineer.

AUGUSTUS W. SHALLCROSS has severed his connections as draftsman and designer with the Layne and Bowler Company, Houston, Tex., and has accepted the position of designer and chief draftsman with R. P. Clark and Company, engineers of the same city.

GEORGE H. JEWELL has resigned as manager of sales of the Lytton Manufacturing Corporation, to become identified with the Chicago office of the Builders Iron Foundry of Providence, R. I., manufacturers of Venturi meters and special recording instruments.

ROBERT W. ELLINGHAM has become affiliated with The Bilton Machine Tool Company, Bridgeport, Conn., a new corporation formed by the consolidation of The Standard Manufacturing Company and The Parsons Foundry Company. Mr. Ellingham was until recently connected with the Remington Arms and Ammunition Company, Bridgeport, Conn., in the capacity of assistant superintendent.

ANNOUNCEMENTS

PERCY H. THOMAS has been granted a patent for a system of electrical distribution.

PAUL WEEKS has become associated with the Holt Engineering Company, of Stockton, Cal.

RALPH BLUMENFELD has entered the employ of the Bayonne Steel Casting Company, Bayonne, N. J.

WALTER J. WARDER, JR., has accepted a position with Roth Brothers and Company, Chicago, Ill.

AMASA M. HOLCOMBE has accepted a commission as Captain in the Ordnance Section of the Officers' Reserve Corps, U.S.A.

J. M. SPITZGLASS, mechanical engineer of Chicago, Ill., has become associated with the Republic Flow Meters Company of Chicago, Ill.

ALEXANDER ENGBLOM, formerly mechanical superintendent of Sidney Blumenthal and Company, Shelton, Conn., expects to go to Sweden shortly.

W. E. BEST has severed his connection with the National Cash Register Company of Dayton, O., as superintendent, in which capacity he served for the past five years.

J. J. FLATHER is one of six professors who have been asked by the War Department to act as a scientific research board for the district of the State of Minnesota.

CORNELIUS T. MYERS has devised a "tractive factor" formula for rating motor trucks. This formula has been made the basis of governmental computations on trucks and tractors.

EDMUND D. CAMPBELL, of St. Louis, Mo., has been commissioned as Captain in the Engineers' Section of the Officers' Reserve Corps, and assigned to active duty at Camp Riley, Kansas.

CARLYLE D. BIDWELL, mechanical engineer with the International Harvester Corporation, Akron, O., has been transferred to Milwaukee, Wis., as plant engineer of the Milwaukee Works of the company.

WILLIAM F. DURAND and CHARLES P. STEINMETZ have been elected members of the American Philosophical Society. Professor Durand has also been elected a member of the National Academy of Sciences.

DANA W. WILBER, of Rochester, N. Y., has been ordered to Madison Barracks, New York, with recommendation for the rank of Captain in the Engineer Officers' Reserve Corps, from the War Department.

CLARENCE E. BILTON, president of the Bilton Machine Tool Company, Bridgeport, Conn., has been elected president of the Manufacturers' Association of that city, to succeed James G. Ludlam, resigned.

WILLIAM D. ENNIS, since 1907 head of the department of mechanical engineering in the Polytechnic Institute, Brooklyn, N. Y., has been appointed Major of the Ordnance Section, Officers' Reserve Corps, under date of May 5, 1917.

EDWIN J. PEIRCE, JR., production engineer of New York, has returned from a trip to Kansas City, Mo., in the interests of the Automatic Bookkeeping Register Company. Mr. Peirce is making a specialty of organizing for increased production.

FREDERICK U. CONARD, formerly with the Jennings Lace Works, Brooklyn, N. Y., and now employed by the Public Service Gas Company of Newark, N. J., is at present on leave of absence on account of military duties. He holds a commission as Second Lieutenant in the Engineer Officers' Reserve Corps and is stationed at Fort Oglethorpe, Tenn.

CHARLES WHITING BAKER has retired from the position of editor of *Engineering News-Record* and has become consulting editor of the journal. FREDERICK E. SCHMITT, who was associate editor of *Engineering News* from 1902 until its consolidation with *Engineering Record* as *Engineering News-Record*, a few weeks ago, succeeds Mr. Baker as editor.

JOHN P. FLIPPEN, formerly chief engineer of the C. H. Wheeler Manufacturing Company, Pittsburgh, Pa., is now district manager of that company's interests in Western Pennsylvania, Ohio and West Virginia, with offices in Cleveland and Pittsburgh. Mr. Flippen is operating in conjunction with the Baker Dunbar Allen Company, contracting engineers.

FRED. A. GEIER, president of the Cincinnati Milling Machine Company, Cincinnati, O., and a former trustee of the University of Cincinnati, has made a gift of $25,000 to the University which will be known as the Fred. A. Geier Students' Loan Fund. The annual interest is to be used to provide loans to students of the coöperative engineering course who need financial assistance.

WILLIAM H. WINTERROWD, assistant chief mechanical engineer of the Canadian Pacific Railway, has just returned to this continent after an absence abroad of over 3½ months. He accompanied George Bury, senior vice-president of the Canadian Pacific Railway to Russia, which was visited at the request of the British and Russian Governments in connection with transportation problems.

APPOINTMENTS

EDWARD FLAD, consulting engineer, of St. Louis, has been appointed to succeed John Kennish on the Public Service Commission of Missouri.

ARTHUR S. HAWKS, formerly assistant chief engineer of the Busch-Sulzer Bros-Diesel Engine Company, St. Louis, Mo., has been appointed chief engineer in the company.

JULIAN KENNEDY, Vice-President, Am.Soc.M.E., of Pittsburgh, has been appointed a member of the State Committee on Public Safety by M. G. Brumbaugh, Governor of Pennsylvania.

WILLIAM SMITH has been appointed general master mechanic of the Brandywine Works of the Midvale Steel Company, Coatesville, Pa. He was formerly associated with the company as assistant to superintendent of the special forge department.

CHARLES R. RICHARDS, professor of mechanical engineering at the University of Illinois, and head of the department since 1911, has been appointed dean of the College of Engineering and director of the Engineering Experiment Station to succeed Dr. W. F. M. Goss, who has become president of the Railway Car Manufacturers' Association.

AUTHORS

W. KNIGHT is the author of an article on Explanation of the Failures of Materials, which appears in the May 10 number of the *American Machinist*.

J. PAUL CLAYTON has contributed an article entitled Electric Cooking in Small Cities, to the May 5 issue of the *Electrical Review and Western Electrician*.

WILLIAM T. DONNELLY has contributed an illustrated article on the Problem of the Wooden Cargo Ship, to the May issue of *International Marine Engineering*.

C. F. HIRSHFELD presented a paper on Some Low-Temperature Electrothermic Processes at the Detroit convention of the American Electrochemical Society, May 2 to 5.

JOHN A. MATHEWS presented a paper on Comments on the Electrical Steel Industry at the May 2 to 5 meeting of the American Electrochemical Society, held in Detroit, Mich.

SAMUEL S. WYER is the author of Electrolysis Damages from Single-Trolley Electric Railways which appears in Vol. 23, No. 11 of *Case and Comment*, The Lawyer's Magazine.

H. COLE ESTEP, editorial director of the Penton Publishing Company, Cleveland, O., addressed the Philadelphia Foundrymen's Association, May 2, on The Cleaning of Castings.

ALLEN F. BREWER is the author of an interesting article in the *Engineering News-Record* for April 19, comparing the suitability and cost of portable frame buildings with canvas tents for use in modern military encampments.

RICHARD G. WILLIAMS presented a paper on The Grinding Wheel—A Connected Link between the Electric Furnace and the Automobile, at the 31st general meeting of the American Electrochemical Society, held in Detroit, May 2 to 5.

VICTOR W. ZILEN is the author of an article on Reversible Steam Turbine for Driving Locomotives, which appears in the May 1 issue of *Power*. This article deals with the preliminary design of steam turbines and with locomotive turbine performance.

CLAUDE HARTFORD has contributed articles on Up-to-Date Methods of Selling Steam, and the New Station of the New York Steam Company, which appear in the April issue of *The Heating and Ventilating Magazine* and the April 15 number of *The Bulletin of the National District Heating Association*, respectively. He is also the author of an article entitled New High-Pressure Central Steam Plant, which appears in the February 6 issue of *Power*.

THE NEW BOOKS

ALL books received by The Journal will be listed under this heading, generally accompanied by brief descriptive notes. Works of special importance to mechanical engineers will be commented on at length by members and others peculiarly qualified by reason of their experience and training.

Engineering Chemistry

Engineering Chemistry. By Thomas B. Stillman, M.Sc., Ph.D., Late Professor of Engineering Chemistry in the Stevens Institute of Technology, etc. The Chemical Publishing Co., Easton, Pa., 1916. Cloth, 5¾ x 8¾ in., 760 pp., 150 illustrations. $5.

The present edition of Engineering Chemistry is fully up to the reputation of its ancestors and is a fit memorial to its noted author. Notable improvements over the previous editions are found in the chapters on coal and coke, asphalt and paving materials, coal tar and derived oils, and gas analysis.

The work is planned primarily for the use of analytical and testing laboratories, for which it is invaluable. Although containing only 760 pages, it gives in excellent form methods for testing many of the common engineering materials. In addition to the chapters mentioned above, it includes methods for iron and steel, alloys, cements, building materials, oils, lubricants, soaps, paints, paper, and water for industrial purposes.

The general treatment of the various subjects may well be illustrated by the chapter on coal and coke. In this chapter there is given, first, in brief form, the technical methods of analysis and, then, in more detail, alternative and more exact methods. After this there follow notes and comments on the analytical methods, forms for reporting the analyses and tests, and, finally, specifications of large consumers of the various kinds of coal or coke. The determination of calorific value is described in a most satisfactory manner.

In the chapters on alloys and on oils and lubricants, Dr. Stillman has collected a great deal of information which it would be difficult to equal in another work of the same size. These chapters will be appreciated especially by those engineers who have been confronted, for example, with the necessity of determining quickly the composition of a sample of white metal or of detecting the presence of grease in a lubricant which has been found unsatisfactory.

The description of asphalt and pavement materials, and their physical and chemical examination, has been so expanded as to make this a chapter of great interest to municipal laboratories and highway engineers. The various asphalts and mixtures, methods for the examination of bituminous road materials, and the essential constituents for road construction and maintenance are discussed in considerable detail.

Since the book is of most value as a manual for the laboratory, it is not surprising that the author has found impossible the inclusion of lengthy theoretical discussions. Usually, only sufficient general descriptive matter is given to familiarize the chemist with those properties which are dependent upon compositions or conditions which may be tested for in the laboratory. While the effect of various ingredients on the hardness and other physical properties of iron or steel is stated clearly, we have found no mention of the different modifications of ferrite.

On the whole, the publication is a most valuable one and one which should be available to every chemist or engineer interested in analytical or testing work.

CHARLES L. REESE.

Steam Boilers

Steam-Boilers. By H. deB. Parsons, B.S., M.E., Consulting Engineer, Member of the Am.Soc.M.E., A.S.C.E., Soc. Naval Arch. and Marine Engineers, etc. Longmans, Green & Co., New York, 1917. Cloth, 6 x 9 in., xvii + 377 pp., 157 illustrations. $4 net.

This book was written by a former professor of engineering and now a prominent consulting engineer in New York at first as a series of lectures to his pupils, and later, by certain changes, as a general book on boilers and collateral matters, such as the chemistry of combustion, fuels, boiler fittings, chimneys and other means of creating draft, smoke prevention, boiler coverings, etc. The first edition appeared in 1903, and the edition under review in 1917. Its purpose is to give its readers some general ideas concerning the matters mentioned above and of features of construction of the various common types of fire-tube boilers. Of water-tube boilers there is very little said, "because the manufacturers of such boilers issue complete illustrated descriptions and dimension sheets."

The author's aim is apparently not to go far beyond generalities, although he has evidently looked closely into details of construction, etc., and in them is well versed. He has succeeded well, and while designers of boilers seldom look into books, except the A.S.M.E. and similar Codes, young men will find the book very helpful, and any one interested in the subject of boilers will find it a good book to possess. In some respects the book is not up to date, as will appear below.

The diagrams were evidently prepared for this book, and it is gratifying that they are not taken from trade catalogues.

The book is what I suppose would be called "analytical," rather elementary, but sufficiently advanced for most purposes, and the illustrative examples are well worked out. The material is original as far as practicable in treating such a well-worn subject.

The early pages of the book are devoted to temperatures, specific heat, latent heat, factor of evaporation, combustion, cause and prevention of smoke, methods of firing, kinds of fuel, and definitions of fuel, combustible and efficiency.

I observe that the statement is made, as it is by many persons besides the author, that a large combustion volume is necessary for good results. I never accepted this dictum fully, for I have found that corrugated-furnace and locomotive-type boilers give as good gas analyses as others.

Chapter V begins with a general definition of boilers and the distinction is made between "boilers" and "generators," the former being the fire-tube types and the latter the more modern devices for containing water in tubes and drums. Here, and in several other places, the author states that the "generators" contain less water than the "boilers" in proportion to their relative horsepowers. If the author should compute some of these volumes he might modify these statements. While speaking of the two types, the author calls them, except here and there, "fire tubular" and "water tubular" instead of the more common fire-tube and water-tube.

In discussing the rating of boilers I think the author attaches undue importance to the arrangements of surfaces.

He speaks of tube plates of boilers not being very effective heating surface, but I have always considered such plates of fire-tube boilers nearest the firebox as immensely effective.

I have stated that in some particulars the book is not up to date. Among the reasons for this statement are the engraving of the end of a cylindrical boiler which is made in four sections and a central patch instead of a head in one piece; a view of a horizontal return-tubular boiler (Figs. 11 and 12) with both heads flanged in, which violates the principle which he lays down elsewhere that heads should be so placed that all joints can be riveted by a machine; the view of a vertical boiler (Fig. 15) which has a brick ashpit, and a cast-iron plate under the base or mud ring, both of which prevent calking the lower joints without raising the boiler; a fire-door opening formed in part by the mud ring and the remainder by a forged ring solid with it; the reversed flange wide and flat, both of which have caused disaster in many cases; and a form of smoke-box covering which leaks air to a serious extent. Present-day construction employs a cast-iron ashpit which, at the top, is narrower than the mud ring and thus permits the bottom joints to be calked without removing anything. It also forms fire-door openings by flanging the plates and permitting the water to surround the opening. It is well to mention these things because the young engineer may feel justified in copying designs shown in a book by a prominent author.

It would have been well in discussing the submerged-tube-plate vertical boiler (Fig. 14) to have called attention to the complicated nature of the stresses in the upper tube plate and cone, the bending of the former when subjected to the test pressure, and the best manner of staying the cone. It may be well to call attention to the depth and double riveting of the mud ring in this figure, both of which are never employed except in some very large boilers, and then probably without sufficient reason.

A curious error in detail of boiler construction is given in Fig. 13, p. 81, in which the lower tube plate of a vertical boiler is flanged outside of the firebox inner plate.

In describing the different methods of supporting boilers it would have been well to have dwelt upon the importance of supporting all shell boilers at two points in the length, and mentioned that any such boiler regarded as a girder, is subjected to only an insignificant stress from its weight if supported only at the ends. Mr. Woolson's elegant three-point method is described but insufficiently praised. The method of supporting Lancashire boilers is that generally used, viz., by employing several supporting cradles; but even that boiler, long as it is, should rest on only two points. This method is employed in the Galloway boiler shown in Fig. 19.

There is very little to be said concerning matter relating to marine boilers as that is orthodox, but it would have been well to mention the great diameters, great thicknesses of plates, and high pressures employed at the present time, as for instance on the *Aquitania* and the new *Britannic*—recently sunk.

Reference is made several times to good steaming boilers, but to me it has always seemed as if a good steaming boiler is one that is large for its work, or that has a very strong draft.

The chapter on chimney draft is useful, but it would have been more logical to place it in another part of the book rather than between the descriptions of boilers and the materials of their construction.

The chapter on Materials is good and the A.S.M.E. Code is here made use of. In this chapter it is stated that "Many boilers have been exploded by permitting water to collect on top of cast-iron stop valves." Is it possible that this is true?

In the chapter on Boiler Details the use of the elastic limit instead of the ultimate strength of plate in determining the thickness is advocated, which is, of course, correct. The late Mr. Leavitt is the only engineer that I have ever known to use this method. The boiler braces shown on pp. 200-201 have the usual defects of being able to straighten out where bent, and bringing most of the stress on one rivet.

The matter relating to riveted joints is deficient in illustrating a defective and obsolete type of joint in Fig. 75, and in not pointing out the defect of the prevailing type of butt joint used in this country, viz., that of having a narrow strap on one side of the joint and a wide one on the other. The defect is that the joint is non-central resisting, and therefore one which bends under stress, causes the plate to crack, and is likely to cause explosions. Tests of joints and experience show this. Nor is the advantage of butt joints with the straps of equal widths and all rivets in double shear in doing away with these defects mentioned.

It is gratifying to see that drilling holes from the solid is advocated, and I feel that this and the use of butt joints with all rivets in double shear are sure to be features of American boiler practice in the near future.

I am glad to see that the author condemns domes on stationary boilers as being useless and sources of weakness. I should advocate condemning brazed copper steam pipes, as they have caused several severe explosions.

Under the head of Boiler Fittings the down-draft grate is described and it is stated that for grates of equal area the capacity of a down-draft grate is greater than that of an up-draft. This is doubtful, inasmuch as in the latter the fire is drawn away from the fresh coal, and not through it.

The chapter on Mechanical Stokers is seriously defective because it gives nothing about the widely used underfed stokers known as the Taylor, Riley, Westinghouse, Combustion Engineering Co's. Type *E*, and Jones, nor any illustrations of chain grates which are so efficient in burning the western high volatile coals. Neither does it mention pulverized coal sufficiently, which has so recently become prominent and bids fair to be of immense importance to the railroads in utilizing the poorest coals and lignite, and in maintaining steady steam pressure.

The matter on Artificial Draft, Incrustation, Corrosion, General Wear and Tear, and Explosions does not call for special mention, but it is gratifying that a book now states that "Explosions occur when the steam pressure exceeds the resisting strength of the metal structure," instead of attributing them to mysterious causes.

Other matter relating to Chimney Design, Smoke Prevention, Testing Boilers, Boiler Trials, Boiler Coverings, Care of Boilers, and Superheaters is good.

F. W. DEAN.

Stresses in Wire-Wrapped Guns and in Gun Carriages. By Lieut.-Col. Colden L'H. Ruggles. John Wiley & Sons, Inc., New York, 1916. Cloth, 6 x 9 in, 259 pp., 94 illustrations. $3.

This work, which explains a number of the important engineering principles underlying the design of wire-wrapped guns and of gun carriages, was originally prepared for the use of the cadets of the U. S. Military Academy. Its chapters deal successively with elastic strength of wire-wrapped guns; determination of the forces brought upon the principal parts of the 3-inch field carriage and a disappearing gun carriage by the discharge of the gun; stresses in parts of gun carriages; toothed gearing; counter recoil springs.